Marvin & Associates.
Yellowstone
County traffic safety
improvement study.

YELLOWSTONE COUNTY

TRAFFIC SAFETY IMPROVEMENT STUDY

PREPARED BY

MARVIN & ASSOCIATES

SEPT., 1985

MARVIN & ASSOCIATES

Traffic, Transportation & Civil Engineers

Suite 304 Transwestern I
404 N. 31st
Billings, MT 59107

Ph.: (406) 248-5088

Les Muhlbeier
Yellowstone Co. Traffic Engineer
P.O. Box 35023
Billings, MT 59107

September 27, 1985

Re: Shepherd Road
Speed Zone Study

Dear Les :

Attached are five copies of this letter, Spot Speed data and analysis sheets and a Plan and Speed Profile sheet for the above noted study. This study was completed at your request and was partially funded by the Department of Justice, Highway Traffic Safety. One of these copies should be forwarded to Harry Lauer of that agency.

It is my understanding that a request from the Shepherd High School was the basis of need for this study. Representatives the high school had requested a 25 mph zone in front of the school. I assume that the reason for this request was to slow traffic down in front of the school for the safety of students. Since there have been physical changes as well as changes in traffic volumes in the Shepherd area since the existing speed zone was originally established, an Engineering study was conducted. The following is a summary of the study results and recommendations:

Four Spot Speed stations were selected for data collection sites. The site locations represent critical points as far as adjacent land use and traffic flow are concerned. The station locations are shown on the attached plan sheet.

A significant representation of vehicle speeds were gathered with the use of a Radar Gun provided by Yellowstone County. Data collection methods followed accepted Engineering standards and procedures. The speed data was entered into a micro computer which provided the attached analysis sheets. The 85th percentile speeds and the pace speed ranges are the most important of the analysis results found on those sheets.

The 85th percentile speed is the speed that 85 % of all vehicles are traveling at or below and it is usually the basis of establishing speed limits unless other circumstances involving the roadway, roadside culture or vehicle operating conditions are present which would warrant a reduced speed limit.

The following 85th percentile speeds were recorded at the spot speed stations:

STATION	LOCATION	NORTHBOUND 85TH % (mph)	SOUTHBOUND 85TH % (mph)
A	2,200 ft. S. of Shep. Int.	53.5	51.0
B	1,000 ft. S. of Shep. Int.	44.9	43.4
C	400 ft. N. of Shep. Int.	44.6	46.9
D	2,800 ft. N. of Shep. Int.	55.8	56.5

The speed profile represents plots of these speeds. A dip in the profile occurs due to the presence of the school and the Shepherd Road East intersection where significant turning movements occur. However, the majority of motorists travel above the posted speed limit (35 mph) within this section of Shepherd Road. This fact can be verified by interpreting the attached graphic plots of the speed data.

Since Shepherd High School and other roadside development within this section of roadway has less than desirable access control, limited sight distance, some pedestrian activity and significant vehicular approach traffic, a reduction below the 85 th percentile speed appears to be warranted. Therefore, the existing 35 mph speed zone should remain. The location of the zone should be shifted and incremental zoning should be initiated to more closely match approaching and departing traffic speeds. The plan and profile sheet indicates the recommended zone locations and required signing.

As far as a 25 mph zone is concerned, no evidence exists which would warrant such a drastic reduction. Operational observations and accident records both indicate that there has not been a significant safety problem in front of the school. A 25 mph zone would create a situation where 100 % of all motorists are breaking the law and enforcement would be economically impossible.

Reducing the speed limit to 25 mph "when children are present" or contingent on other conditions is also not possible. School speed zones are usually reserved for elementary schools where children cannot be expected to exercise responsible judgement. In a high school situation it would be inappropriate.

Sincerely,

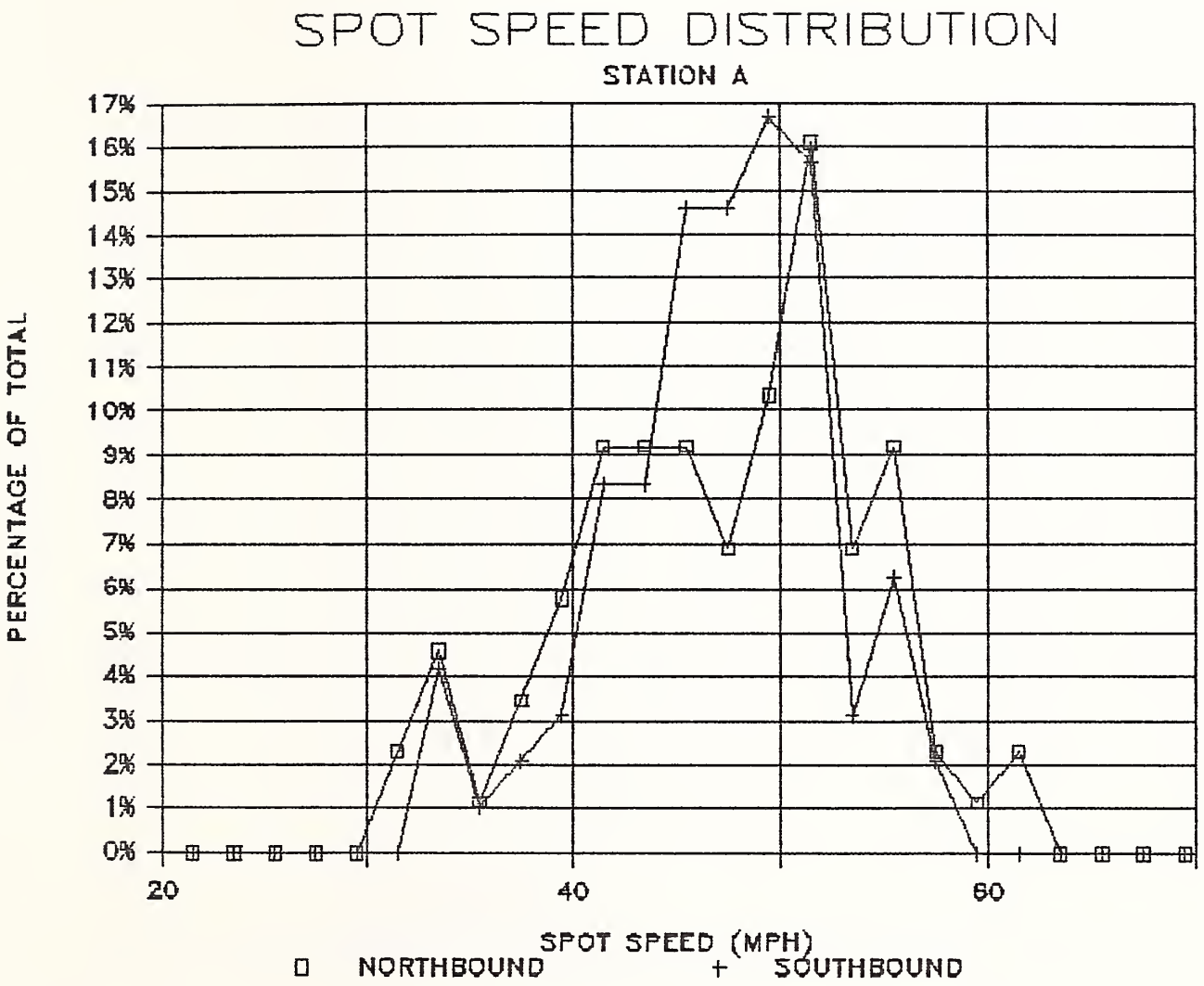
Robert R. Marvin, P.E.

SPOT SPEED SUMMARY

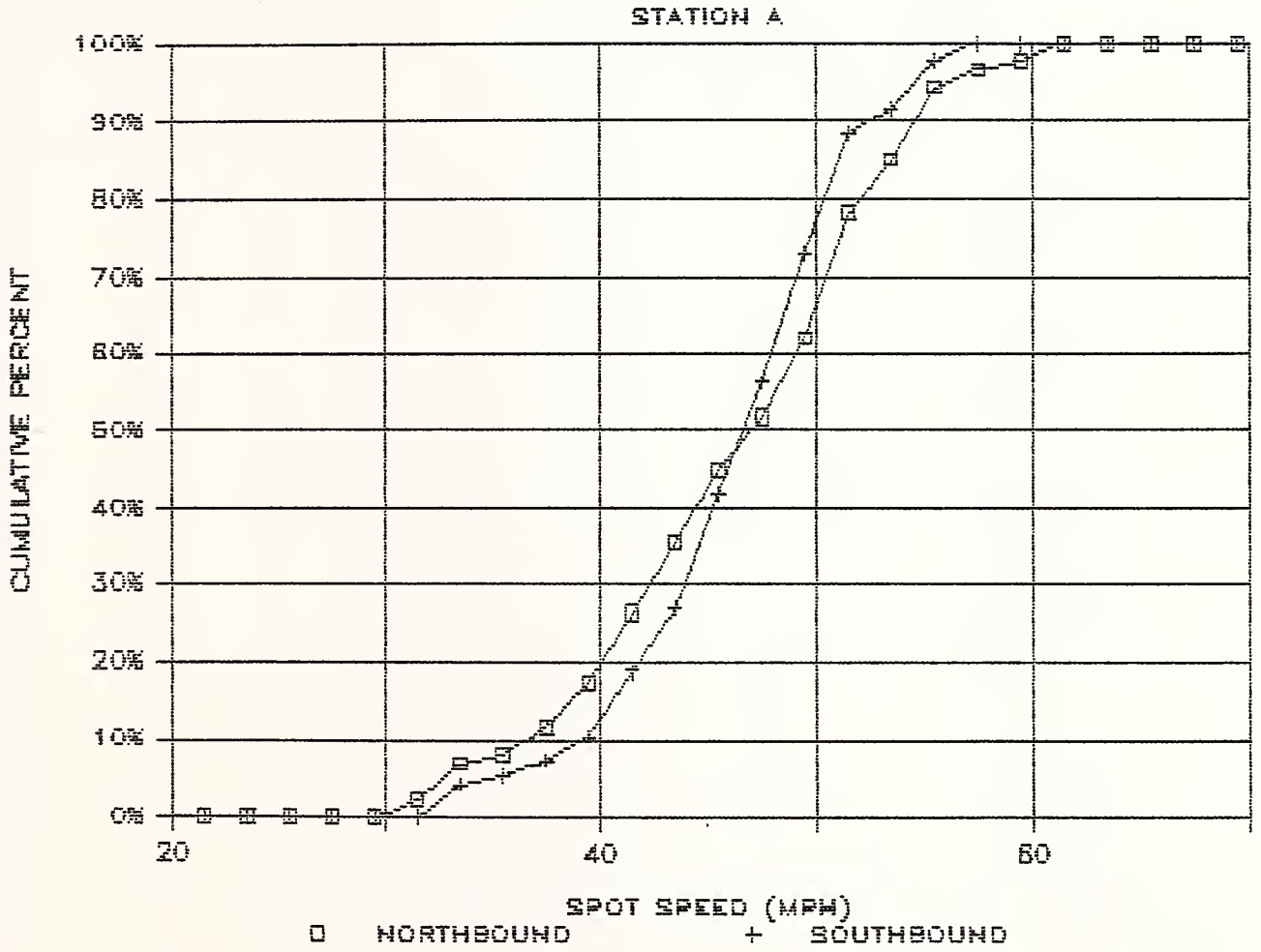
LOCATION: SHEPHERD RD. STATION: STATION A TIME : 4:15-5:30 PM
WEATHER: CLEAR & WARM DATE : 9/18/85

DIRECTION OF TRAVEL: NORTHBOUND					DIRECTION OF TRAVEL: SOUTHBOUND				
SPEED RANGE-MPH	RANGE AVERAGE	COUNT FREQ.	% OF TOTAL	CUM. %	SPEED RANGE-MPH	RANGE AVERAGE	COUNT FREQ.	% OF TOTAL	CUM. %
21-22	21.5	0	0.0%	0.0%	21-22	21.5	0	0.0%	0.0%
23-24	23.5	0	0.0%	0.0%	23-24	23.5	0	0.0%	0.0%
25-26	25.5	0	0.0%	0.0%	25-26	25.5	0	0.0%	0.0%
27-28	27.5	0	0.0%	0.0%	27-28	27.5	0	0.0%	0.0%
29-30	29.5	0	0.0%	0.0%	29-30	29.5	0	0.0%	0.0%
31-32	31.5	2	2.3%	2.3%	31-32	31.5	0	0.0%	0.0%
33-34	33.5	4	4.6%	6.9%	33-34	33.5	4	4.2%	4.2%
35-36	35.5	1	1.1%	8.0%	35-36	35.5	1	1.0%	5.2%
37-38	37.5	3	3.4%	11.5%	37-38	37.5	2	2.1%	7.3%
39-40	39.5	5	5.7%	17.2%	39-40	39.5	3	3.1%	10.4%
41-42	41.5	8	9.2%	26.4%	41-42	41.5	8	8.3%	18.8%
43-44	43.5	8	9.2%	35.6%	43-44	43.5	8	8.3%	27.1%
45-46	45.5	8	9.2%	44.8%	45-46	45.5	14	14.6%	41.7%
47-48	47.5	6	6.9%	51.7%	47-48	47.5	14	14.6%	56.3%
49-50	49.5	9	10.3%	62.1%	49-50	49.5	16	16.7%	72.9%
51-52	51.5	14	16.1%	78.2%	51-52	51.5	15	15.6%	88.5%
53-54	53.5	6	6.9%	85.1%	53-54	53.5	3	3.1%	91.7%
55-56	55.5	8	9.2%	94.3%	55-56	55.5	6	6.3%	97.9%
57-58	57.5	2	2.3%	96.6%	57-58	57.5	2	2.1%	100.0%
59-60	59.5	1	1.1%	97.7%	59-60	59.5	0	0.0%	100.0%
61-62	61.5	2	2.3%	100.0%	61-62	61.5	0	0.0%	100.0%
62-64	63.5	0	0.0%	100.0%	62-64	63.5	0	0.0%	100.0%
65-66	65.5	0	0.0%	100.0%	65-66	65.5	0	0.0%	100.0%
67-68	67.5	0	0.0%	100.0%	67-68	67.5	0	0.0%	100.0%
69-70	69.5	0	0.0%	100.0%	69-70	69.5	0	0.0%	100.0%
TOTALS =		87	100%		TOTALS =		96	100%	

15 th PERCENTILE =	38.9	MPH	15 th PERCENTILE =	40.6 MPH
50 th PERCENTILE =	46.9	MPH	50 th PERCENTILE =	46.6 MPH
85 th PERCENTILE =	53.5	MPH	85 th PERCENTILE =	51.0 MPH
PACE =	41-52	MPH	PACE =	41-52 MPH
MEAN SPEED =	47.1	MPH	MEAN SPEED =	47.1 MPH


SPOT SPEED DISTRIBUTION
STATION A
PERCENTAGE OF TOTAL
17%
16%
15%
14%
13%
12%
11%
10%
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
20
40
60
SPOT SPEED (MPH)
NORTHBOUND
SOUTHBOUND

SPOT SPEED CUMULATIVE DISTRIBUTION



SPOT SPEED SUMMARY

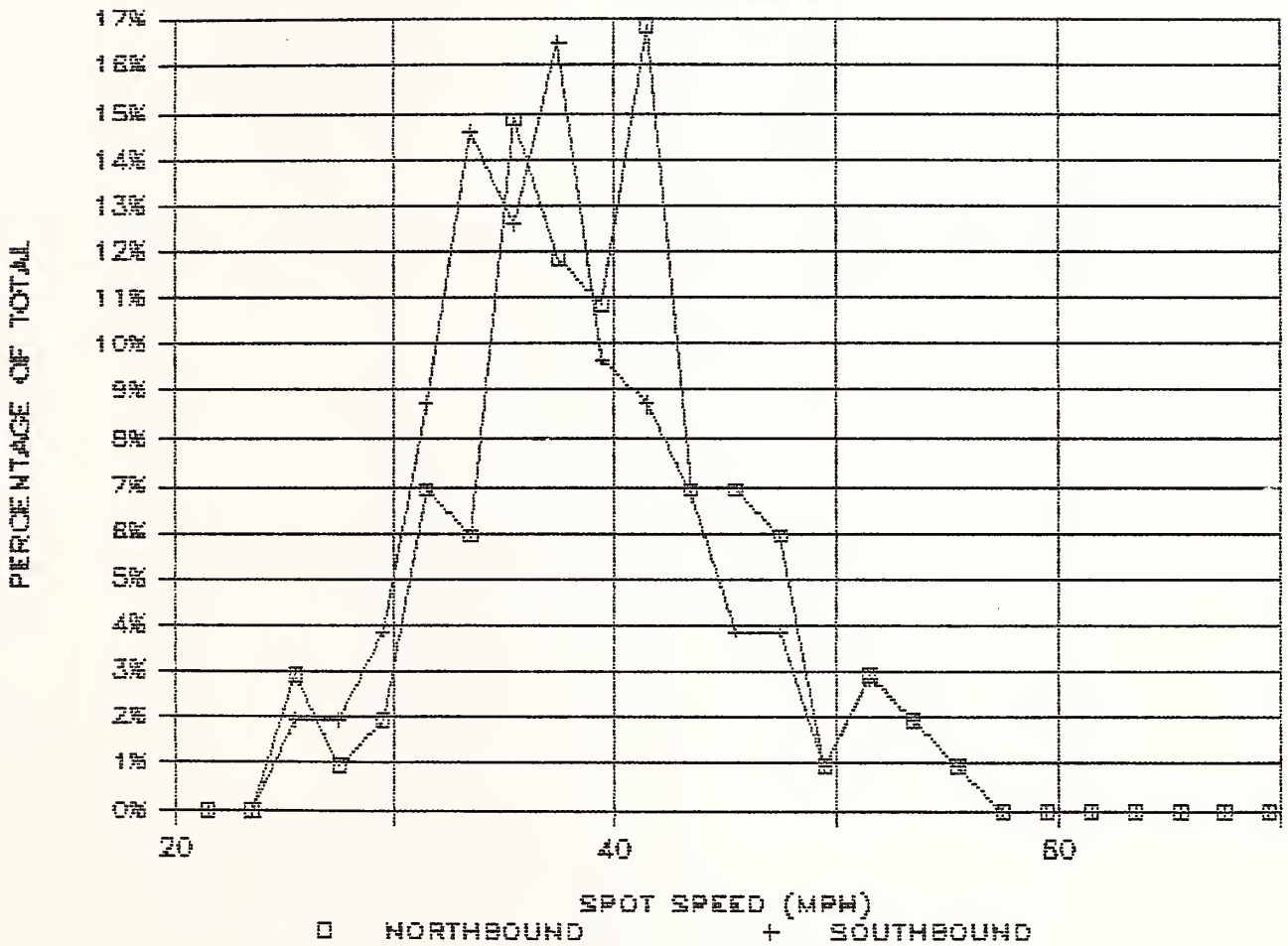
LOCATION: SHEPHERD RD. STATION: STATION B TIME : 2:45-4:15 PM
WEATHER: CLEAR & WARM DATE : 9/18/85

DIRECTION OF TRAVEL: NORTHBOUND					DIRECTION OF TRAVEL: SOUTHBOUND				
SPEED RANGE-MPH	RANGE AVERAGE	COUNT FREQ.	% OF TOTAL	CUM. %	SPEED RANGE-MPH	RANGE AVERAGE	COUNT FREQ.	% OF TOTAL	CUM. %
21-22	21.5	0	0.0%	0.0%	21-22	21.5	0	0.0%	0.0%
23-24	23.5	0	0.0%	0.0%	23-24	23.5	0	0.0%	0.0%
25-26	25.5	3	3.0%	3.0%	25-26	25.5	2	1.9%	1.9%
27-28	27.5	1	1.0%	4.0%	27-28	27.5	2	1.9%	3.9%
29-30	29.5	2	2.0%	5.9%	29-30	29.5	4	3.9%	7.8%
31-32	31.5	7	6.9%	12.9%	31-32	31.5	9	8.7%	16.5%
33-34	33.5	6	5.9%	18.8%	33-34	33.5	15	14.6%	31.1%
35-36	35.5	15	14.9%	33.7%	35-36	35.5	13	12.6%	43.7%
37-38	37.5	12	11.9%	45.5%	37-38	37.5	17	16.5%	60.2%
39-40	39.5	11	10.9%	56.4%	39-40	39.5	10	9.7%	69.9%
41-42	41.5	17	16.8%	73.3%	41-42	41.5	9	8.7%	78.6%
43-44	43.5	7	6.9%	80.2%	43-44	43.5	7	6.8%	85.4%
45-46	45.5	7	6.9%	87.1%	45-46	45.5	4	3.9%	89.3%
47-48	47.5	6	5.9%	93.1%	47-48	47.5	4	3.9%	93.2%
49-50	49.5	1	1.0%	94.1%	49-50	49.5	1	1.0%	94.2%
51-52	51.5	3	3.0%	97.0%	51-52	51.5	3	2.9%	97.1%
53-54	53.5	2	2.0%	99.0%	53-54	53.5	2	1.9%	99.0%
55-56	55.5	1	1.0%	100.0%	55-56	55.5	1	1.0%	100.0%
57-58	57.5	0	0.0%	100.0%	57-58	57.5	0	0.0%	100.0%
59-60	59.5	0	0.0%	100.0%	59-60	59.5	0	0.0%	100.0%
61-62	61.5	0	0.0%	100.0%	61-62	61.5	0	0.0%	100.0%
62-64	63.5	0	0.0%	100.0%	62-64	63.5	0	0.0%	100.0%
65-66	65.5	0	0.0%	100.0%	65-66	65.5	0	0.0%	100.0%
67-68	67.5	0	0.0%	100.0%	67-68	67.5	0	0.0%	100.0%
69-70	69.5	0	0.0%	100.0%	69-70	69.5	0	0.0%	100.0%
TOTALS =		101	100%		TOTALS =		103	100%	

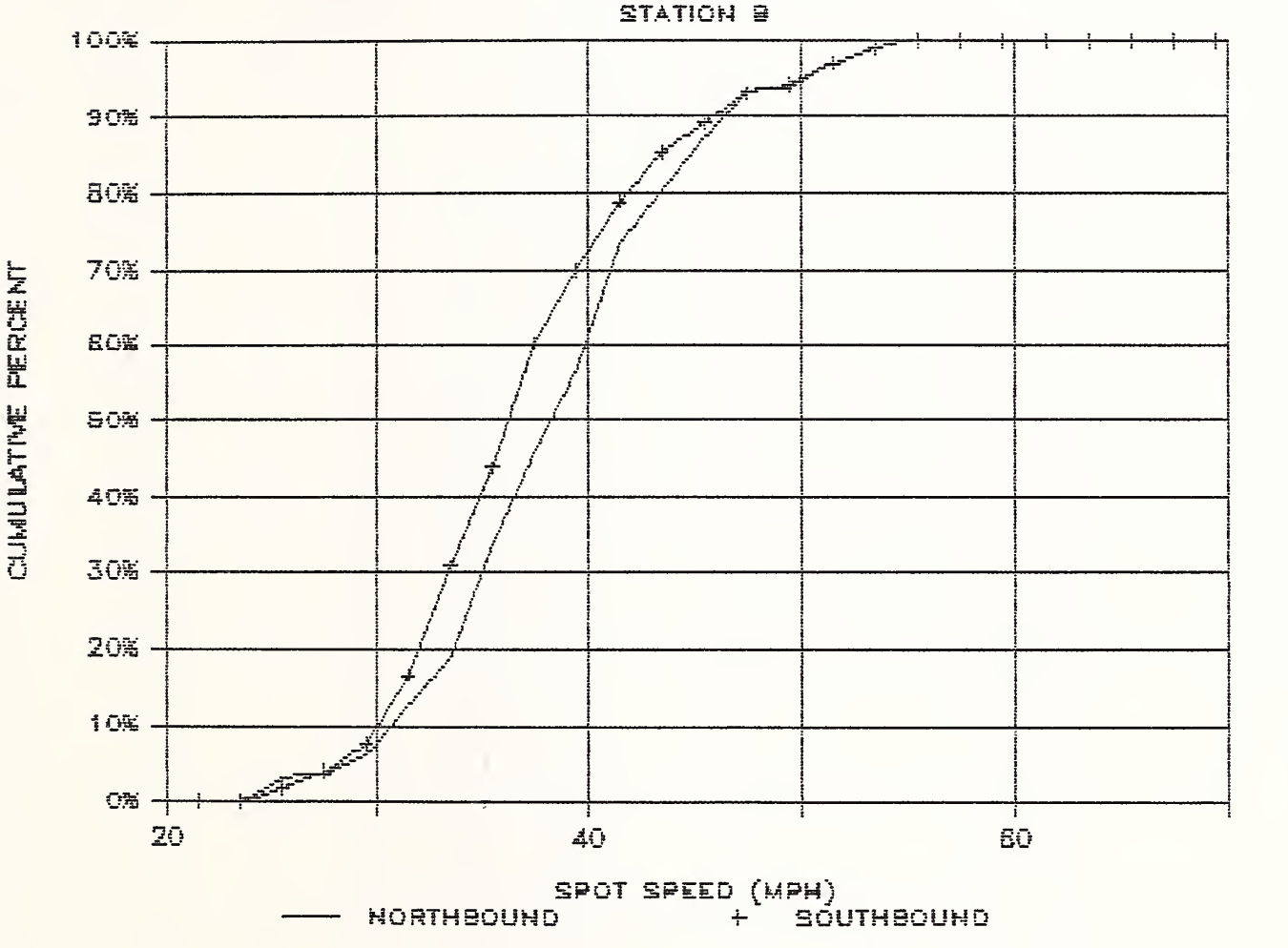
15 th PERCENTILE =	30.2	MPH	15 th PERCENTILE =	31.2 MPH
50 th PERCENTILE =	38.3	MPH	50 th PERCENTILE =	36.9 MPH
85 th PERCENTILE =	44.9	MPH	85 th PERCENTILE =	43.4 MPH
PACE =	35-46	MPH	PACE =	31-42 MPH
MEAN SPEED =	39.4	MPH	MEAN SPEED =	38.1 MPH

SPOT SPEED DISTRIBUTION

STATION 8



SPOT SPEED CUMULATIVE DISTRIBUTION



SPOT SPEED SUMMARY

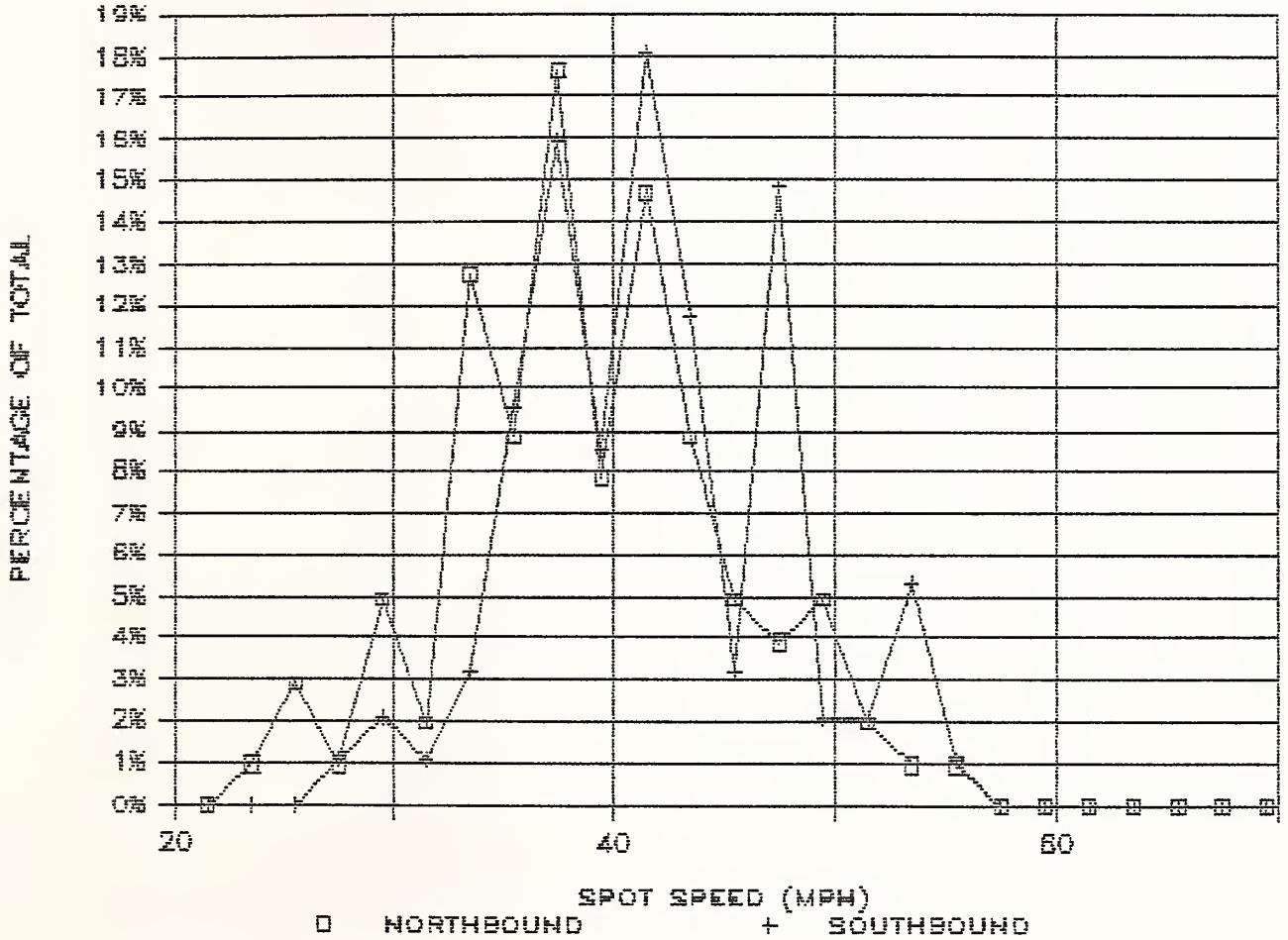
LOCATION: SHEPHERD RD. STATION: STATION C TIME : 3:30-5:15 PM
WEATHER: CLEAR & WARM DATE : 9/24/85

DIRECTION OF TRAVEL: NORTHBOUND					DIRECTION OF TRAVEL: SOUTHBOUND				
SPEED RANGE-MPH	RANGE AVERAGE	COUNT FREQ.	% OF TOTAL	CUM. %	SPEED RANGE-MPH	RANGE AVERAGE	COUNT FREQ.	% OF TOTAL	CUM. %
21-22	21.5	0	0.0%	0.0%	21-22	21.5	0	0.0%	0.0%
23-24	23.5	1	1.0%	1.0%	23-24	23.5	0	0.0%	0.0%
25-26	25.5	3	2.9%	3.9%	25-26	25.5	0	0.0%	0.0%
27-28	27.5	1	1.0%	4.9%	27-28	27.5	1	1.1%	1.1%
29-30	29.5	5	4.9%	9.8%	29-30	29.5	2	2.1%	3.2%
31-32	31.5	2	2.0%	11.8%	31-32	31.5	1	1.1%	4.3%
33-34	33.5	13	12.7%	24.5%	33-34	33.5	3	3.2%	7.4%
35-36	35.5	9	8.8%	33.3%	35-36	35.5	9	9.6%	17.0%
37-38	37.5	18	17.6%	51.0%	37-38	37.5	15	16.0%	33.0%
39-40	39.5	8	7.8%	58.8%	39-40	39.5	8	8.5%	41.5%
41-42	41.5	15	14.7%	73.5%	41-42	41.5	17	18.1%	59.6%
43-44	43.5	9	8.8%	82.4%	43-44	43.5	11	11.7%	71.3%
45-46	45.5	5	4.9%	87.3%	45-46	45.5	3	3.2%	74.5%
47-48	47.5	4	3.9%	91.2%	47-48	47.5	14	14.9%	89.4%
49-50	49.5	5	4.9%	96.1%	49-50	49.5	2	2.1%	91.5%
51-52	51.5	2	2.0%	98.0%	51-52	51.5	2	2.1%	93.6%
53-54	53.5	1	1.0%	99.0%	53-54	53.5	5	5.3%	98.9%
55-56	55.5	1	1.0%	100.0%	55-56	55.5	1	1.1%	100.0%
57-58	57.5	0	0.0%	100.0%	57-58	57.5	0	0.0%	100.0%
59-60	59.5	0	0.0%	100.0%	59-60	59.5	0	0.0%	100.0%
61-62	61.5	0	0.0%	100.0%	61-62	61.5	0	0.0%	100.0%
62-64	63.5	0	0.0%	100.0%	62-64	63.5	0	0.0%	100.0%
65-66	65.5	0	0.0%	100.0%	65-66	65.5	0	0.0%	100.0%
67-68	67.5	0	0.0%	100.0%	67-68	67.5	0	0.0%	100.0%
69-70	69.5	0	0.0%	100.0%	69-70	69.5	0	0.0%	100.0%
TOTALS =		102	100%		TOTALS =		94	100%	

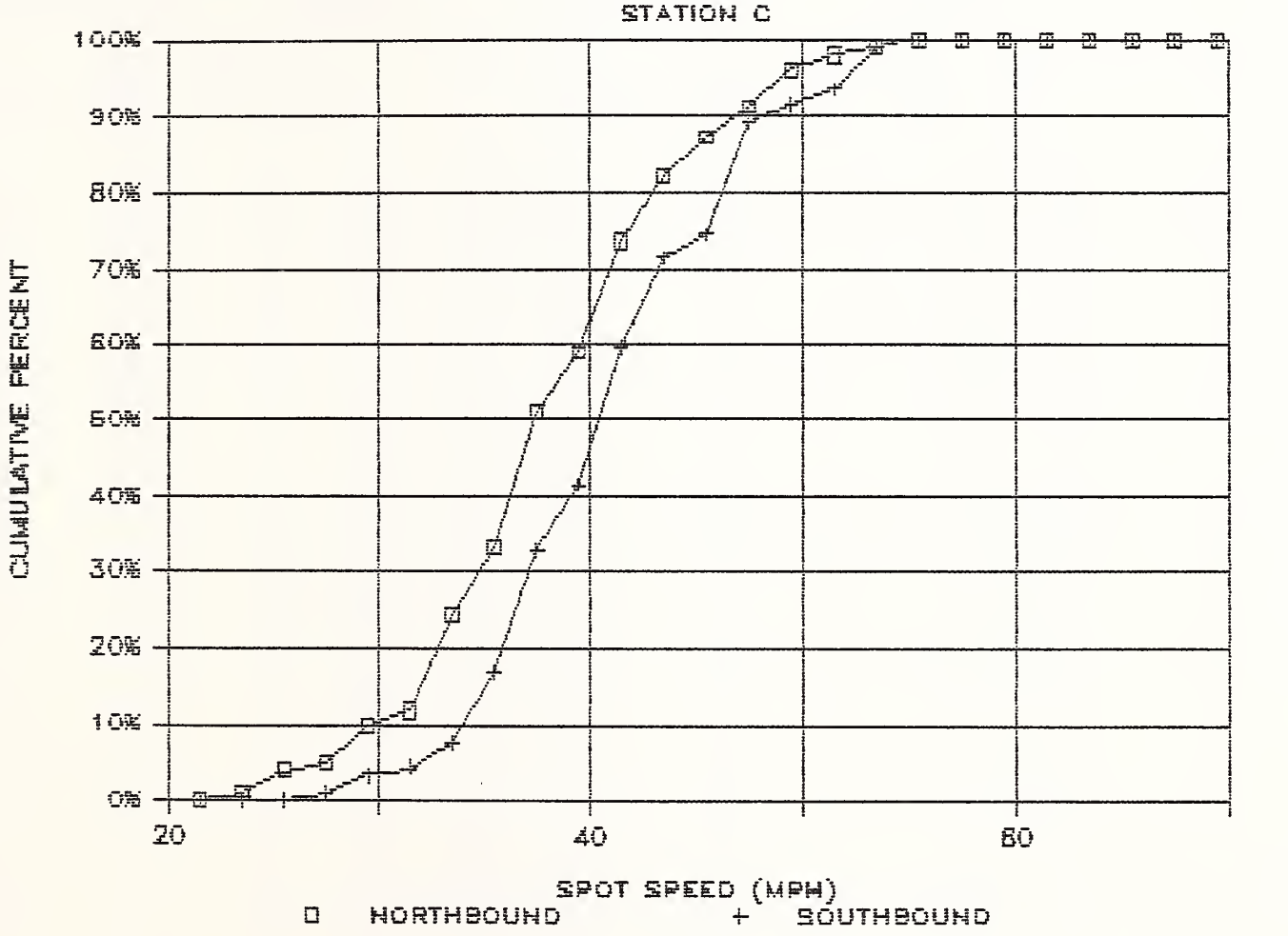
15 th PERCENTILE =	24.0	MPH	15 th PERCENTILE =	35.1 MPH
50 th PERCENTILE =	37.2	MPH	50 th PERCENTILE =	41.0 MPH
85 th PERCENTILE =	44.6	MPH	85 th PERCENTILE =	46.9 MPH
PACE =	33-44	MPH	PACE =	37-48 MPH
MEAN SPEED =	39.0	MPH	MEAN SPEED =	41.8 MPH

SPOT SPEED DISTRIBUTION

STATION C



SPOT SPEED CUMULATIVE DISTRIBUTION



SPOT SPEED SUMMARY

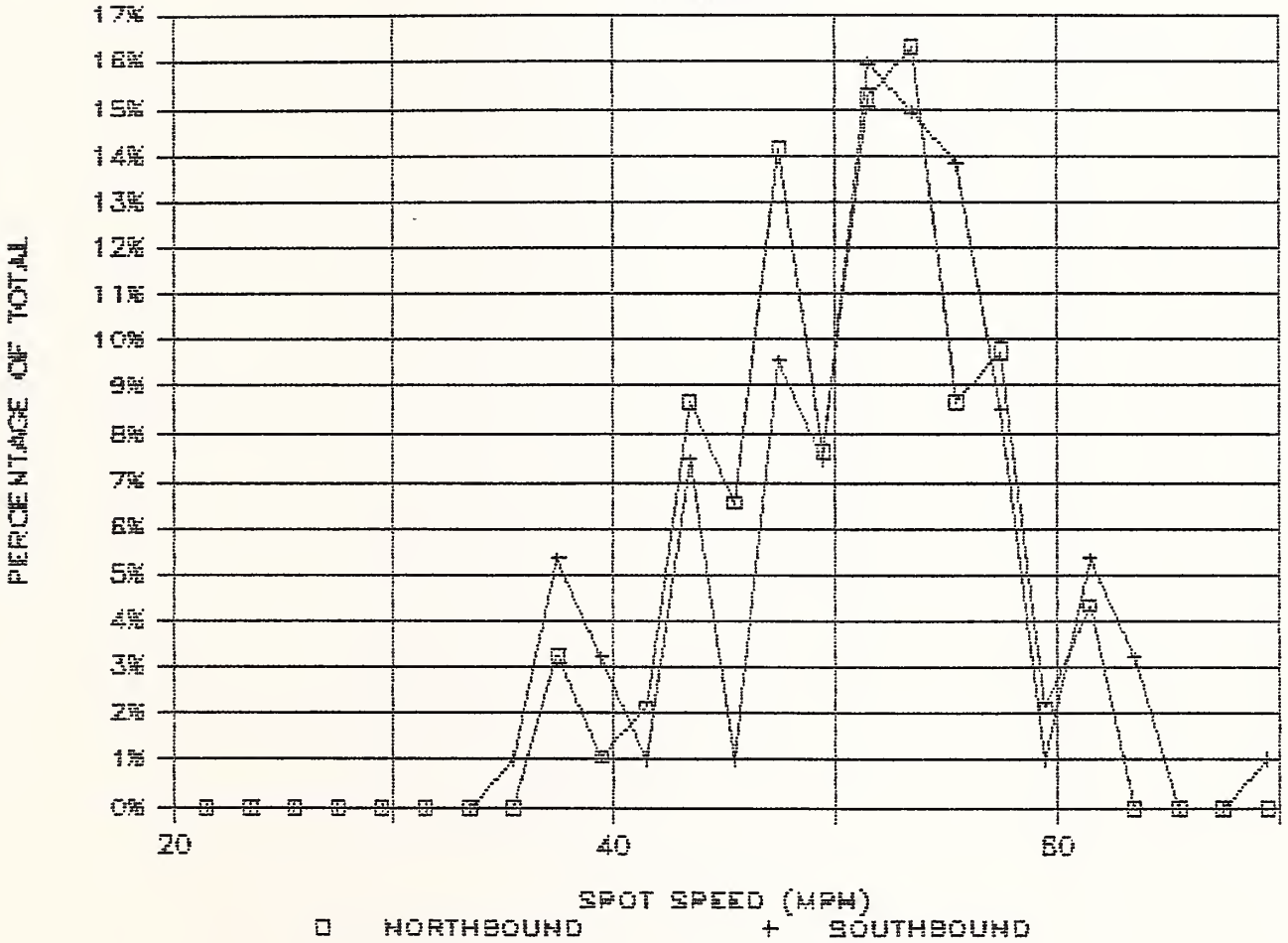
LOCATION: SHEPHERD RD. STATION: STATION 0 TIME : 3:45-5:30 PM
WEATHER: CLEAR & WARM DATE : 9/20/85

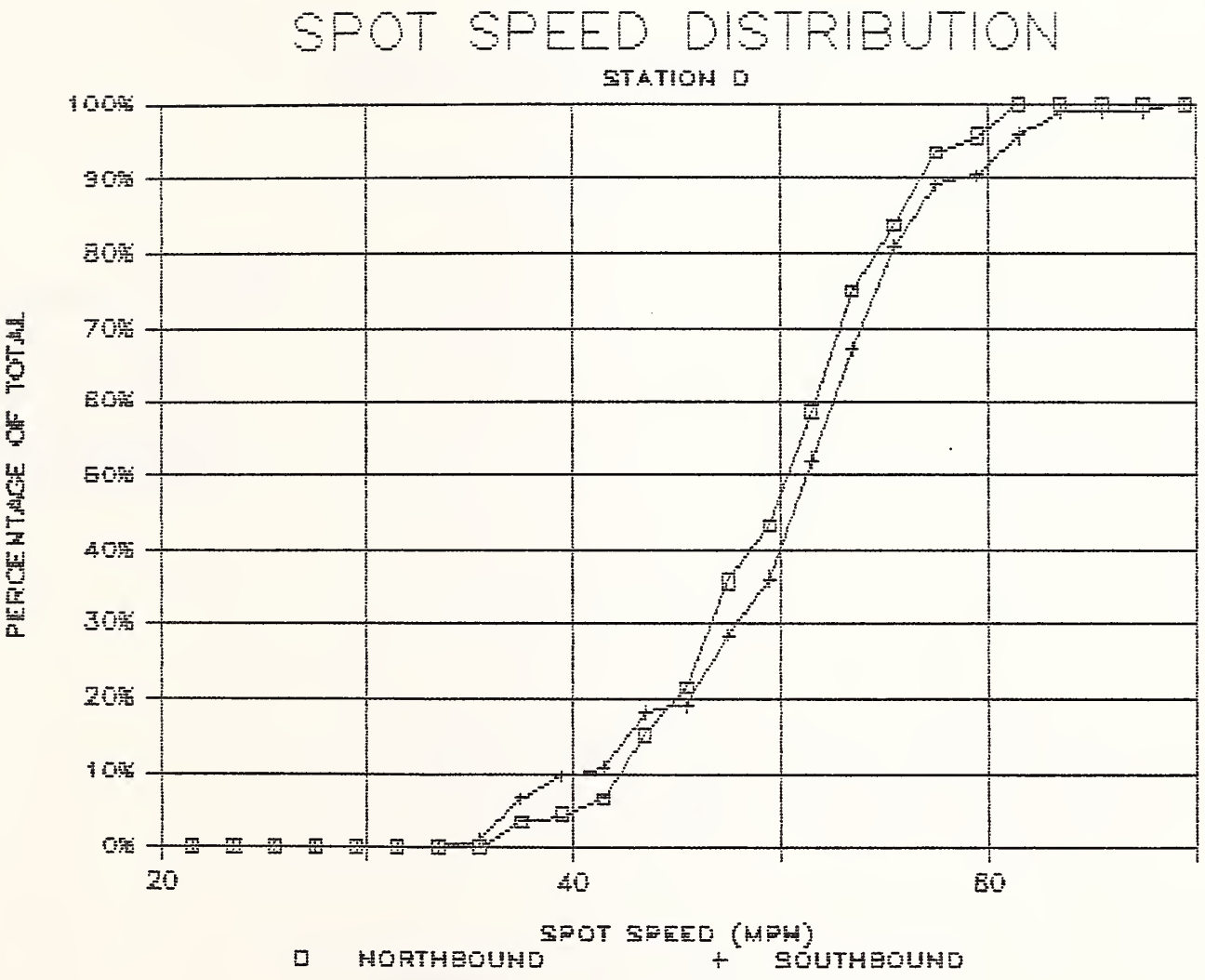
DIRECTION OF TRAVEL: NORTHBOUND					DIRECTION OF TRAVEL: SOUTHBOUND				
SPEED RANGE-MPH	RANGE AVERAGE	COUNT FREQ.	% OF TOTAL	CUM. %	SPEED RANGE-MPH	RANGE AVERAGE	COUNT FREQ.	% OF TOTAL	CUM. %
21-22	21.5	0	0.0%	0.0%	21-22	21.5	0	0.0%	0.0%
23-24	23.5	0	0.0%	0.0%	23-24	23.5	0	0.0%	0.0%
25-26	25.5	0	0.0%	0.0%	25-26	25.5	0	0.0%	0.0%
27-28	27.5	0	0.0%	0.0%	27-28	27.5	0	0.0%	0.0%
29-30	29.5	0	0.0%	0.0%	29-30	29.5	0	0.0%	0.0%
31-32	31.5	0	0.0%	0.0%	31-32	31.5	0	0.0%	0.0%
33-34	33.5	0	0.0%	0.0%	33-34	33.5	0	0.0%	0.0%
35-36	35.5	0	0.0%	0.0%	35-36	35.5	1	1.1%	1.1%
37-38	37.5	3	3.3%	3.3%	37-38	37.5	5	5.3%	6.4%
39-40	39.5	1	1.1%	4.3%	39-40	39.5	3	3.2%	9.6%
41-42	41.5	2	2.2%	6.5%	41-42	41.5	1	1.1%	10.6%
43-44	43.5	8	8.7%	15.2%	43-44	43.5	7	7.4%	18.1%
45-46	45.5	6	6.5%	21.7%	45-46	45.5	1	1.1%	19.1%
47-48	47.5	13	14.1%	35.9%	47-48	47.5	9	9.6%	28.7%
49-50	49.5	7	7.6%	43.5%	49-50	49.5	7	7.4%	36.2%
51-52	51.5	14	15.2%	58.7%	51-52	51.5	15	16.0%	52.1%
53-54	53.5	15	16.3%	75.0%	53-54	53.5	14	14.9%	67.0%
55-56	55.5	8	8.7%	83.7%	55-56	55.5	13	13.8%	80.9%
57-58	57.5	9	9.8%	93.5%	57-58	57.5	8	8.5%	89.4%
59-60	59.5	2	2.2%	95.7%	59-60	59.5	1	1.1%	90.4%
61-62	61.5	4	4.3%	100.0%	61-62	61.5	5	5.3%	95.7%
62-64	63.5	0	0.0%	100.0%	62-64	63.5	3	3.2%	98.9%
65-66	65.5	0	0.0%	100.0%	65-66	65.5	0	0.0%	98.9%
67-68	67.5	0	0.0%	100.0%	67-68	67.5	0	0.0%	98.9%
69-70	69.5	0	0.0%	100.0%	69-70	69.5	1	1.1%	100.0%
TOTALS =		92	100%		TOTALS =		94	100%	

15 th PERCENTILE =	43.5	MPH	15 th PERCENTILE =	42.7 MPH
50 th PERCENTILE =	50.4	MPH	50 th PERCENTILE =	51.2 MPH
85 th PERCENTILE =	55.8	MPH	85 th PERCENTILE =	56.5 MPH
PACE =	47-58	MPH	PACE =	47-56 MPH
MEAN SPEED =	50.8	MPH	MEAN SPEED =	51.5 MPH

SPOT SPEED DISTRIBUTION

STATION D




SPOT SPEED DISTRIBUTION
STATION D
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
PERCENTAGE OF TOTAL
20
40
60
SPOT SPEED (MPH)
NORTHBOUND
SOUTHBOUND

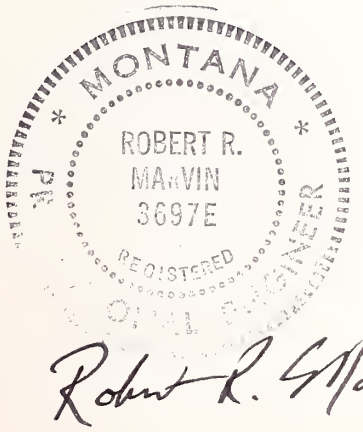
YELLOWSTONE COUNTY

TRAFFIC SAFETY IMPROVEMENT

STUDY

prepared by

MARVIN & ASSOCIATES
Suite 304 Transwestern I
Billings, Montana 59107



September, 1985

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INTRODUCTION

Study Purpose

Yellowstone County, in an effort to reduce or otherwise alleviate problems at accident cluster sites on the County Road System, had retained the Consulting Engineering Firm of Marvin & Associates to perform a traffic engineering study. The purpose of this study was to identify accident cluster locations, collect and analyze pertinent data, make short and long term safety improvement recommendations and establish a priority list of improvement projects.

This is the second such study completed in Yellowstone County. A previous study, DCA Project No. 79-04-01-01, was completed approximately five years ago and was the first such study within the State of Montana. Both of these studies were completed with technical and organizational assistance of the Department of Justice, Highway Traffic Safety Division (formerly the Department of Community Affairs).

The study methodology, which primarily served as the basis for the analysis within this report, can be found in the report No.FHWA-RD-77-83 "Identification of Hazardous Locations". Refinements to the FHWA report made by DCA Project No. 79-04-01-01 and subsequent county studies throughout the state are also incorporated within this report. The methodology used to establish priority rankings is explained in the Benefit/Cost Ratio section of this report and is tailored specifically to Yellowstone County's unique requirements.

The analysis of site data and hazard ranking was performed on a micro computer. The Lotus 123 software was used to develop templates that are available for future use in establishing priority improvement project lists and will greatly aid in program continuation.

Report Organization

Site specific data can be found within the tabbed sections of this report. A great deal of computer generated data was printed and reduced for inclusion on the existing condition and short term improvement sketches. The availability of pertinent data on the same page as the sketches hopefully aids in comprehension of the problem identification and improvement benefits.

Color photos of site conditions have been included in two master sets of this report. Black and white photo copies have been inserted in the remaining reports in the interest of economy.

The basic format of the site specific sections is as follows:

Narratives

* Location Description
* Existing Conditions
    - Geometrics
    - Traffic Control Devices
    - Traffic Volumes
    - Traffic Operations
    - Accidents
* Short Term Improvements
* Long Term Improvements
* Benefits
* Funding Considerations

Figures

~ Photos

~ Existing Condition Sketch

~ Short Term Improvement Sketch

SITE CHARACTERISTICS

Site Locations

The maps on the following pages (Figure 1.) show the twenty sites respective to their priority numbers. The following is a list of site numbers corresponding to the site locations:

TABLE 1. SITE LOCATIONS

SITE NUMBER	INTERSECTION LOCATION
1	GRAND AVE & 54TH STREET W
2	SHEPHERD ROAD & CHICAGO ROAD
3	HIGHWAY 10E - GOLF COURSE RD
4	OLD HARDIN ROAD & BECRAFT LANE
5	12 MILE RD & HOMER DAVIS RD
6	OLD HARDIN RD & PICCOLO LANE
7	HIGHWAY 312 - SHEPHERD ROAD
8	SHEPHERD RD & SHEPHERD RD E
9	OLD HARDIN RD & DICKIE RD
10	NEIBAUR ROAD CURVE
11	JELLISON ROAD CURVE
12	DOVER ROAD & PIONEER ROAD
13	HIGHWAY 312 & DOVER RD
14	HIGHWAY 312 - McGIRL ROAD
15	DANFORD RD & 56TH STREET W
16	HIGHWAY 312 & BARRY ROAD
17	COBURN ROAD & ROSEBUD LANE
18	HIGHWAY 312 & DRURY LANE
19	HIGHWAY 312 & HUNTLEY APP RD
20	KING AVENUE W & 32ND STREET W

System Characteristics

As can be seen from the site location maps, the accident sites are mainly concentrated in three areas:

Highway 312 - Shepherd

Lockwood

West Billings

Even though these areas are geographically separated, the roadway, traffic control and operating features are similar. Differences are notable only with respect to roadside land use, and traffic volumes. Four of the sites: Old Hardin & Becraft, Old Hardin & Piccolo, Coburn & Rosebud and King & 32nd St. have sufficient roadside development and turning movement volumes to be classified as urban intersections. The remainder of the sites are typically rural.

The rural sites are all similar in geometric features and in the magnitude of traffic control device application. It is gratifying to observe that most of the sites, along with most of Yellowstone County's road system have at least a minimum degree of signing and pavement markings. The existing signing is, for the most part, consistent in application and well maintained.

The major problem observed was in the placement of signs. In particular, warning signs and stop signs were consistently located at inappropriate locations. The advanced intersection and stop ahead signs are all located within 500 feet of the intersection. MUTCD states that 750 feet is typical for rural roads. In most cases the shorter distance makes the sign ineffective, and sometimes blocks clear vision of the stop sign. Because of this, improvement recommendations within this report call for the relocation of warning signs.

In addition, it was determined that expectancy was a problem at most rural intersections. Because most intersections have a similar appearance and motorists are not provided sufficient information regarding the identity of an intersecting road, inadequate reaction time is provided. To improve this situation, most of the recommendations require a supplementary street name sign to be added to advanced warning signs as provided in section 2D-39 of the MUTCD.

Since consistency of signing is extremely important, Yellowstone County should plan on revising the applications and locations of signs on all county roads when these improvements are implemented. Standard signing applied consistently will aid in the elimination of accidents county wide.

The accident reports combined with field observation indicate that there may also be a problem with maintenance on some sections of roads. Pavement markings at most locations were badly worn. The county should review its striping program to determine a method of performing periodic restriping. At some locations the striping may have to be remeasured since there may not be enough lines left to provide sufficient guidance to the stripping crew.

The higher traffic volume locations require more vigilance during winter maintenance conditions. It is realized that the county has many miles of roadway to clear during the winter, but high volume intersection areas should take priority. Several of the locations had significant numbers of accidents clustered around a small period of time when icy conditions were prevalent. This may indicate that once the snow is removed repeat visits to sand and/or salt the intersections are lacking.

The site locations with urban characteristics also share a

common problem. There appears to have been a lack of proper developmental controls to provide for proper traffic access to the adjacent streets from businesses. Traffic operations at the four previously mentioned urban type sites, with the exception of King and 32nd, are dominated by roadside developments. Because of uncontrolled access conditions, traffic control devices alone cannot aid accident problems to any significant degree. Recommended improvements therefore had to incorporate physical modifications to the sites. These improvements may not be implementable unless the county has a legal mechanism to effect the changes.

Future Improvements

Two of the three general areas where the accident cluster sites are located should be of major concern to Yellowstone County and should be given increased attention by the Planning Board.

Old Hardin Road - has taken the brunt of continually steady subdivision growth within the last 10 years. Traffic volumes ranging from 13,000 ADT near I-90 to 4,800 ADT near Johnson Lane have stressed the safety and capacity of the narrow roadway. Continuous roadside development between those two points have virtually no access control and thus capacity of the road is limited. With current volumes the level of service is below design standards. To make matters worse, there has been a notably deterioration in the roadway surface.

The one salvation for Old Hardin Road may be the new I-90 Interchange at Johnson Lane. Its existence would immediately relieve pressures on Old Hardin Road and because of its location it would reduce impacts of future development. It is recommended that the planning agency assess traffic impacts of future developments in

Lockwood to ensure that major problems are not perpetuated along Old Hardin Road.

Highway 312 - was previously the main highway east of Billings. When the interstate system east of Billings was completed the road reverted to localized access. As with most roads of this nature, the state Department of Highways transfers control of the road to local governments. Because these type of roads are usually old, maintenance responsibility is not readily accepted by the local governments primarily due to funding restrictions. This is the case with Highway 312.

Highway 312 extends from its western terminus at the Roundup turnoff in the Billings Heights to a point approximately 30 miles east at the Pompeys Pillar I-94 Interchange. It is a 26 foot wide two lane roadway with outdated roadside design standards. Traffic volumes range from 7,600 ADT near the Roundup Turnoff to 2,200 ADT near Huntley.

Continued, steady residential development has occurred along its length in the past 10 to 15 years. The largest areas of growth has occurred within the first mile of Billings and within the Shepherd area. This growth has naturally increased traffic on Highway 312 which in turn is spawning roadside business developments. Several night club type establishments have located along the highway within the recent past and there is evidence of other future commercial concerns locating along the road.

While not at design capacity along most of its length at present, increasing traffic volumes combined with additional roadside access may soon stress the level of service on Highway 312 between Billings and Shepherd. Already there has been a notable decrease in the safety of the facilities as witnessed by the six accident cluster

sites included in this study. Other sites could have been included within this study but in one case the MDOH Off System Safety Program is already designing a project at Five Corners and in the other cases accidents were sufficiently separated that clusters were not entirely definable.

This study addresses individual cluster sites but the county should recognize that there is a generalized problem along Highway 312 and that traffic control device installation must be consistent along its length. In addition, the Planning Board should carefully evaluate traffic impacts of future developments east of Billings and especially roadside site developments. If traffic growth continues, a major upgrade project which would include roadway widening and access control would be required.

STUDY METHODOLOGY

The study was segregated into four distinct phases which best achieved the purpose and scope of the traffic study. These phases are outlined as follows:

Phase 1 - Site Selection Phase; was based primarily on the number of accidents at definable cluster sites. A preliminary list of sites was provided Yellowstone County, in addition to cluster maps and accident reports. A complete screening of reports to pinpoint accident locations was completed, and several additional sites were determined to be candidates for inclusion. From the original site listing and the additional site candidates, only statistically significant accident cluster sites were chosen. It was determined that only 20 sites would be included in study due to funding limitations.

During the course of accident report screening, it was noted that several other locations within Yellowstone County have significant accident clusters. Because the majority of these sites were under the Montana Department of Highways maintenance jurisdiction, Yellowstone County felt that the majority of the study should be assigned to sites wholly within county jurisdiction.

Phase 2 - Data Collection Phase; included the preliminary organization of the project including scheduling, site selection, form processing, field data location and reduction of data. Accident data was obtained from reports provided by the Department of Justice. Traffic counts were taken at each location. The average daily traffic was determined by applying factors for hourly, daily and monthly variations.

Other data collected in the field included measurement of road

widths and geometrics, and inventory of traffic control devices, turning movement counts and subjective observation of traffic operations.

As it was collected data was entered into a microcomputer using Lotus 123 software. Specific templates were created which were used in the analysis.

Phase 3 - Analysis of Data; included the determination of hazard indexes for each location by using the Federal Highway Administration Report No. FHWA-RD-77-83 "Identification of Hazardous Locations". Computations involved with accidents, volumes, capacities, indicator values and other aspects of hazard indexes were performed on the microcomputer. From these computations a preliminary hazard ranking list was prepared.

Phase 4 - Evaluation of Corrective Measures and Priority Listing; included the determination of improvements that would reduce or eliminate certain types of hazards in general at the accident locations. Preliminary designs of those improvements included signing, geometric changes, signal modifications, channelization and reconstruction. The improvements were recommended on a short term basis. In some cases, long term improvements were recommended.

Cost effectiveness calculations of the improvements at each location were determined by preparing preliminary cost estimates and computing economic benefits to arrive at a benefit/cost ratio. The composite hazard index ranking and benefit/cost ratio determined the final priority listing.

ERROR ANALYSIS

The analysis of high hazard accident sites by the methods published in FHWA Report No. FHWA-RD-77-83 intrinsically contains some degree of error due to subjective data collection and computational bias. In the application of the method, certain other innate errors appear in various forms. A cursory analysis of these error sources and the relative degree of effect each has on the final index ranking is represented in this section.

Site Selection

The selection of accident sites considered for the inclusion in the analysis must be accomplished according to logical criteria. The following list contains elements of site selection that must be considered in order to develop a manageable number of sites to be studied.

- Accident reports must be available for every section of road within the County's jurisdiction.
- Information on reports must be correct and complete.
- Accidents must be accurately pinpointed as to route and exact location.
- Minimum number of accident criteria must be established to select a list of sites for further review.
- The list should be narrowed further by eliminating those sites that would not exceed a minimum value of accidents per million vehicles.

If any of the above elements are missing from the site selection

process or if any personal or subjective judgement is applied contrary to these elements, statistical bias is introduced into the analysis. Based on the quality of accident reports that were screened in this study, it cannot be stated with any certainty that a total representation of accidents at each location are present.

Ranking Distribution

It must be assumed that a logical and unbiased process of selecting sites in Yellowstone County was completed, those sites should be the most hazardous of all sections of all roads on the county. If a plot of the general population of all sites were made according to the hazard index values, the distribution would appear similar to that of Figure 2. The small area in the high hazard index range represents the number of sites that should be involved in the hazard study.

Figure 3 shows an actual plot of the number of sites falling within certain ranges of index numbers. Although the scales between the normal distribution and the Yellowstone County sites do not match, it is observed that the index range is on the upper side of the normal distribution. This trend is adequate to indicate that the site selection and analysis is satisfactory.

Number Of Accidents Indicator

The average number of accidents per year for all twenty sites was 9.6 which would result in an average indicator value of 66. Judging from the condition and maintenance of accident reporting and filing during the time of the reporting period, in which several accidents may have been either lost or identified at the wrong

location, the number of accidents could have been wrong. Assuming the worst conditions for error analysis purposes, the three reports may be incorrect either by misplaced location or lost, which would produce negative bias. Two reports would result in 0.75 accidents per year error. The indicator value for this site would be 64 causing an negative bias of 5%.

Accident Rate Indicator

Since volume data for the exact period of accident reporting may not exist at some locations, factors adjusting past or present Average Daily Traffic (ADT) to the analysis period were used. Assuming the worst cases of no growth or double growth, the actual ADT during the reporting period would have been negative or positive bias of 6% in the indicator value.

The volume capacity indicator would present a similar bias of lessor magnitude due to ADT factoring.

Hazard Index Error

Based on the foregoing assumptions the average hazard index of 60.2 could be negative or positive. It is unlikely that all bias would be directed in a positive or negative direction. It is most probable that compensating errors occurred in the majority of instances.

HAZARD INDICES

Seven hazard indices were used as the preliminary basis of ranking hazardous sites. The following are brief descriptions of each index including data format, data collection, indicator scaling and site ranking with respect to each index.

1. **Number of Accidents** - This indicator provides a historical background of accidents at the investigation site. In the case of Yellowstone County a four year period was used, which included 1981 - 1984. The accident data had to be photo copied and sent from Helena. Whether the data provided was complete is not known. Continuation of the program using this indicator may present some difficulty since the certainty of receiving all reports at the proper location cannot be guaranteed. However, if an error exists, it may be assumed that it will be consistantly applied within the county.

Figure 4 is a curve extracted from the FHWA report which is used to determine the indicator value. The data base is number of accidents per year. This indicator as all of the seven indicators used in the report is scaled between 0 and 100. An average of two accidents per year in a three year period indicates a hazardous location (indicator value of 33). Ten accidents on the average per year is used to designate a very hazardous location (indicator value of 67).

Table 2 is the computer generated ranking of all sites based on this indicator.

TABLE 2. SITE RANKING BY NUMBER OF ACCIDENTS

RANK NUMBER	INTERSECTION LOCATION	TOTAL ACCIDENTS 4 YEARS	1985 ADT	4 YEAR PERIOD ADT	ACCIDENTS PER MVE	NO. ACC. IND VAL
1	KING AVENUE W & 32ND STREET W	19	9,481	8,723	1.49	83
2	OLD HARDIN ROAD & BECRAFT LANE	18	4,883	4,590	2.69	81
3	HIGHWAY 312 & DOVER RD	15	8,007	7,687	1.34	77
4	GRAND AVE & 54TH STREET W	12	1,990	1,910	4.30	71
5	SHEPHERD RD & SHEPHERD RD E	12	2,106	2,022	4.07	71
6	HIGHWAY 312 - McGIRL ROAD	12	5,297	5,085	1.62	71
7	SHEPHERD ROAD & CHICAGO ROAD	11	1,689	1,621	4.65	69
8	OLD HARDIN RD & PICCOLO LANE	11	8,064	7,419	1.02	69
9	HIGHWAY 312 - SHEPHERD ROAD	9	3,722	3,573	1.73	64
10	HIGHWAY 312 & BARRY ROAD	9	6,436	6,179	1.00	64
11	OLD HARDIN RD & DICKIE RD	8	919	919	5.96	58
12	JELLISON ROAD CURVE	8	2,157	2,114	2.59	58
13	COBURN ROAD & ROSEBUD LANE	7	954	935	5.13	57
14	HIGHWAY 312 & DRURY LANE	7	5,858	5,624	0.85	57
15	DOVER ROAD & PIONEER ROAD	6	216	216	19.03	54
16	DANFORD RD & 56TH STREET W	6	917	908	4.53	54
17	HIGHWAY 10E - GOLF COURSE RD	6	1,409	1,395	2.95	54
18	HIGHWAY 312 & HUNTLEY APP RD	6	2,286	2,195	1.87	54
19	NEIBAUR ROAD CURVE	5	2,933	2,874	1.19	50
20	12 MILE RD & HOMER DAVIS RD	4	555	533	5.14	45
	AVERAGE VALUES	9.6	3,494	3,326	3.66	63.1

2. Accident Rate Indicator - This indicator somewhat compensates for any incomplete information provided by the number of accident indicators in that an exposure value is provided by the relationship between accidents and the total volumes of vehicles using the facility.

The data base for this indicator is expressed as the number of accidents per million entering vehicles. In the case of an intersection, "million entering vehicles" is the sum of the daily average approach volumes on all legs of the intersection, multiplied by the number of days in the analysis period.

The accident rate indicator is a very important part of the hazard index ranking method and data collection is possible only when a continued program of traffic counting had been performed. Spot counts adjusted by yearly volume increases, seasonal variations, daily variations and hourly variations were necessary at most sites to develop an average daily traffic figure applied to the analysis period since documented counts were not available.

Figure 5 represents the graphic plot of accident rate versus indicator value. As before, the indicator value ranges between 0 and 100.

Table 3 is the computer generated ranking of sites based on this indicator.

TABLE 3. SITE RANKING BY ACCIDENT RATE

RANK NUMBER	INTERSECTION LOCATION	TOTAL ACCIDENTS 4 YEARS	1985 ADT	4 YEAR PERIOD ADT	ACCIDENTS PER MVE	ACC RATE IND VAL
1	DOVER ROAD & PIONEER ROAD	6	216	216	19.03	100
2	OLD HARDIN RD & DICKIE RD	8	919	919	5.96	92
3	COBURN ROAD & ROSEBUD LANE	7	954	935	5.13	83
4	12 MILE RD & HOMER DAVIS RD	4	555	533	5.14	83
5	SHEPHERD ROAD & CHICAGO ROAD	11	1,689	1,621	4.65	78
6	DANFORD RD & 56TH STREET W	6	917	908	4.53	77
7	GRAND AVE & 54TH STREET W	12	1,990	1,910	4.30	74
8	SHEPHERD RD & SHEPHERD RD E	12	2,106	2,022	4.07	71
9	HIGHWAY 10E - GOLF COURSE RD	6	1,409	1,395	2.95	56
10	OLD HARDIN ROAD & BECRAFT LANE	18	4,883	4,590	2.69	52
11	JELLISON ROAD CURVE	8	2,157	2,114	2.59	50
12	HIGHWAY 312 & HUNTLEY APP RD	6	2,286	2,195	1.87	39
13	HIGHWAY 312 - SHEPHERD ROAD	9	3,722	3,573	1.73	37
14	HIGHWAY 312 - McGIRL ROAD	12	5,297	5,085	1.62	35
15	KING AVENUE W & 32ND STREET W	19	9,481	8,723	1.49	33
16	HIGHWAY 312 & DOVER RD	15	8,007	7,687	1.34	30
17	NEIBAUR ROAD CURVE	5	2,933	2,874	1.19	27
18	OLD HARDIN RD & PICCOLO LANE	11	8,064	7,419	1.02	23
19	HIGHWAY 312 & BARRY ROAD	9	6,436	6,179	1.00	23
20	HIGHWAY 312 & DRURY LANE	7	5,858	5,624	0.85	21
	AVERAGE VALUES	9.6	3,494	3,326	3.66	54.2

3. **Accident Severity Indicator** - Although there are many factors involved in the severity of accidents, statistical studies over a significant number of years have given fairly reliable dollar values in terms of economic loss for each type of accident. The accident severity indicator correlates a probable cause and effect relationship which aids in the determination of the level of accident reduction measures required. Severity values can also be used as a determinant of benefits resulting from various improvements.

The data base for accident severity is average relative severity in thousands of dollars. Data collection necessary for the use of the severity index is made possible by the accident report form.

The FHWA report presents the relative severity index values for each type of accident. Once the type of accident has been established, Figure 6 enables the user to assess the indicator value. Figure 6 is a graphic plot of the average severity in thousands of dollars versus the indicator value which is based on a scale of 0 to 100.

Table 4 is the computer generated ranking of sites based on this indicator.

TABLE 4. SITE RANKING BY ACCIDENT SEVERITY

RANK NUMBER	INTERSECTION LOCATION	SUM OF SEVERITY VALUES	TOTAL NO. ACC.	AVERAGE SEVERITY INDEX	INDICATOR VALUE
1	HIGHWAY 312 & DRURY LANE	$145,300	7	$20,757	86
2	JELLISON ROAD CURVE	$127,200	8	$15,900	77
3	HIGHWAY 312 - McGIRL ROAD	$169,800	12	$14,150	74
4	NEIBAUR ROAD CURVE	$69,200	5	$13,840	73
5	HIGHWAY 312 & HUNTLEY APP RD	$76,200	6	$12,700	71
6	SHEPHERD ROAD & CHICAGO ROAD	$126,600	11	$11,509	68
7	12 MILE RD & HOMER DAVIS RD	$45,600	4	$11,400	68
8	GRAND AVE & 54TH STREET W	$131,900	12	$10,992	67
9	DOVER ROAD & PIONEER ROAD	$64,000	6	$10,667	66
10	HIGHWAY 10E - GOLF COURSE RD	$59,900	6	$9,983	64
11	DANFORD RD & 56TH STREET W	$59,700	6	$9,950	64
12	HIGHWAY 312 - SHEPHERD ROAD	$85,400	9	$9,489	63
13	HIGHWAY 312 & BARRY ROAD	$84,800	9	$9,422	63
14	HIGHWAY 312 & DOVER RD	$140,500	15	$9,367	62
15	OLD HARDIN ROAD & BECRAFT LANE	$166,800	18	$9,267	62
16	SHEPHERD RD & SHEPHERD RD E	$110,300	12	$9,192	62
17	OLD HARDIN RD & DICKIE RD	$64,600	8	$8,075	58
18	OLD HARDIN RD & PICCOLO LANE	$48,900	12	$4,075	44
19	KING AVENUE W & 32ND STREET W	$71,300	19	$3,753	43
20	COBURN ROAD & ROSEBUD LANE	$21,500	7	$3,071	40
	TOTAL SEVERITY $ =	$1,869,500			
	TOTAL NO. ACC. =		192		
	AVE. SEVERITY / ACC. =			$9,737	
	AVE. IND. VAL / SITE =				63.8

4. Volume to Capacity Ratio Indicator - This indicator not only produces exposure rates but also incorporates existing roadside features and conditions such as traffic type, turning directions, volume mix and number of lanes.

Computation of the volume capacity indicator is expressed as follows:

V/C = ADT/24 HOUR CAPACITY

Data required for the volume capacity ratio involves field measurements of existing geometrics, turning counts and volume mix. The capacity of each section of road or intersection is computed

through methodology presented in the Highway Capacity Manual - 1964. Although this indicator is cumbersome to use by nonexperienced personnel, its inclusion is considered necessary and correlates well in hazardous index ranking. This is one part of the FHWA methods which may need to be updated when the new Highway Capacity Manual is approved.

Figure 7 presents a graphic plot of the volume capacity ratio versus the indicator value which is also scaled between 0 and 100.

Table 5 is the computer generated ranking of the sites based on this indicator.

TABLE 5. SITE RANKING BY VOLUME/CAPACITY RATIOS

RANK NUMBER	INTERSECTION LOCATION	*MAJOR APP. CAPACITY	*MINOR APP. CAPACITY	TOTAL CAPACITY	24 HOUR CAPACITY EQUIV.	AVERAGE ADT	V/C RATIO	V/C INDICATOR VALUE
1	KING AVE. W. & 32ND STREET W.	450	420	870	20,880	8,723	0.42	60
2	OLD HARDIN ROAD & PICCOLO LANE	720	50	770	18,480	7,419	0.40	59
3	HIGHWAY 312 & DOVER ROAD	870	60	930	22,320	7,687	0.34	51
4	HIGHWAY 312 & BARRY RD.	860	50	910	21,840	6,179	0.28	45
5	HIGHWAY 312 & DRURY LANE	720	110	830	19,920	5,624	0.28	45
6	HIGHWAY 312 & McGIRL ROAD	800	80	880	21,120	5,085	0.24	41
7	OLD HARDIN ROAD & BECRAFT LANE	730	60	790	18,960	4,590	0.24	41
8	HIGHWAY 312 & SHEPHERD RD.	510	120	630	15,120	3,573	0.24	41
9	SHEPHERD RD. & SHEPHERD E. RD.	260	140	400	9,600	2,022	0.21	39
10	NEIBAUR ROAD CURVE	750	0	750	18,000	2,874	0.16	34
11	JELLISON ROAD CURVE	700	0	700	16,800	2,114	0.13	31
12	COBURN ROAD & ROSEBUD LANE	225	80	305	7,320	935	0.13	31
13	HIGHWAY 312 & HUNTLEY APP. RD.	570	180	750	18,000	2,195	0.12	30
14	GRAND AVE & 54TH STREET W.	480	260	740	17,760	1,910	0.11	29
15	SHEPHERD RD. & CHICAGO RD.	530	80	610	14,640	1,621	0.11	29
16	DANFORD RD. & 56TH STREET W.	250	250	500	12,000	908	0.08	24
17	HIGHWAY 10 E & GOLF COURSE RD.	790	90	880	21,120	1,395	0.07	23
18	OLD HARDIN ROAD & DICKIE RD.	350	320	670	16,080	919	0.06	21
19	12 MILE RD. & HOMER DAVIS RD.	510	100	610	14,640	533	0.04	16
20	DOVER ROAD & PIONEER ROAD	330	220	550	13,200	216	0.02	11
	AVERAGE VALUES	570	134	704	16,890	3,326	0.18	35.1

5. **Sight Distance Indicator** - This indicator is of significant value in rural locations, especially at intersecting roads. Even though the weighting factor in the hazard index computation is low, it is still considered valuable in determining deficiencies on unimproved county roads.

The data format for using the sight distance indicator is the ratio of actual sight distance to desirable sight distance. The FHWA report presents the minimum stopping sight distance on wet pavement for the various design speeds. Actual stopping sight distance is the distance from the drivers position to the point where a stop may be required to avoid a hazardous maneuver or direct collision.

The data format for this indicator is the sight distance ratio of actual over desirable. Collection of the sight distance data requires field measurements of sight distance and determination of average travel speeds. Figure 8 presents a graphic plot of the sight distance ratio versus the indicator value which ranges from 0 to 100.

Table 6 is the computer generated ranking of sites based on this indicator.

TABLE 6. SITE RANKING BY SIGHT DISTANCE

RANK NUMBER	INTERSECTION LOCATION	N SD	REQ SD	RATIO	IND VAL	S SD	REQ SD	RATIO	IND VAL	E SD	REQ SD	RATIO	IND VAL	W SD	REQ SD	RATIO	IND VAL	*WT. IND VAL
1	COBURN RD & ROSEBUD LANE	200	550	0.36	100	250	550	0.45	100	100	400	0.25	100	NA	NA	NA	NA	100
2	DOVER RD & PIONEER RD	200	800	0.25	100	NA	NA	NA	NA	1500	650	2.31	0	200	800	0.25	100	100
3	JELLISON ROAD CURVE	NA	NA	NA	NA	NA	NA	NA	NA	200	700	0.29	100	200	700	0.29	100	100
4	OLD HARDIN RD & DICKIE RD	200	550	0.36	100	NA	NA	NA	NA	NA	NA	NA	NA	200	550	0.36	100	100
5	SHEPHERD RD & SHEPHERD RD E	500	650	0.77	54	350	800	0.44	100	1000	650	1.54	8	500	550	0.91	39	85
6	OLD HARDIN RD & BECRAFT LN	500	550	0.91	39	250	550	0.45	100	500	600	0.83	47	500	600	0.83	47	82
7	DANFORD RD & 56TH STREET W	550	800	0.69	67	2000	800	2.50	0	600	650	0.92	38	700	800	0.88	43	59
8	GRAND AVE & 54TH STREET W	850	800	1.06	29	NA	NA	NA	NA	500	800	0.63	70	2000	800	2.50	0	56
9	HIGHWAY 312 & HUNTLEY APP. RD	NA	NA	NA	NA	600	550	1.09	28	2000	800	2.50	0	500	800	0.63	70	56
10	OLD HARDIN RD & PICCOLO LN	NA	NA	NA	NA	500	480	1.04	30	400	550	0.73	59	800	550	1.45	11	49
11	HIGHWAY 312 & DRURY LANE	NA	NA	NA	NA	400	650	0.62	71	2000	800	2.50	0	2000	800	2.50	0	47
12	HIGHWAY 10 E & GOLF COURSE RD	750	650	1.15	24	300	400	0.75	57	2000	800	2.50	0	1500	800	1.88	2	46
13	HIGHWAY 312 & McGIRL RD	500	650	0.77	54	800	650	1.23	20	2000	800	2.50	0	2000	800	2.50	0	43
14	SHEPHERD RD & CHICAGO RD	2000	800	2.50	0	2000	800	2.50	0	1000	650	1.54	9	500	650	0.77	54	39
15	HIGHWAY 312 & SHEPHERD RD	1100	650	1.69	4	500	650	0.77	54	2000	800	2.50	0	2000	800	2.50	0	37
16	NEIBAUR ROAD CURVE	600	550	1.09	27	NA	NA	NA	NA	NA	NA	NA		600	650	0.92	38	34
17	HIGHWAY 312 & DOVER RD	800	410	1.95	1	600	650	0.92	38	1500	800	1.88	2	2000	800	2.50	0	26
18	KING AVE & 32ND STREET W	1500	550	2.73	0	1000	550	1.82	3	800	800	1.00	33	2000	800	2.50	0	23
19	HIGHWAY 312 & BARRY RD	750	550	1.36	14	NA	NA	NA	NA	1500	800	1.88	2	1300	800	1.63	6	11
20	12 MILE RD & HOMER DAVIS RD	2000	650	3.08	0	2000	650	3.08	0	1100	650	1.69	5	1100	650	1.69	5	5

AVERAGE INDICATOR VALUE = 55.0

* WEIGHTED INDICATOR VALUE IS CALCULATED BY THE FORMULA (2xHIGHVAL + 2ndHIGHVAL)/3

N,S,E & W SD's = MEASURED SIGHT DISTANCE ON DIRECTIONAL APPROACHES

6. Driver Expectancy Indicator - This indicator relates human behavior factors to existing road conditions. The value of this indicator is realized in the fact that the roadway geometrics and roadside culture are evaluated on a human judgement basis.

The data format for the driver expectancy index is the problem rating scale. Being a subjective indicator, the degree of expectancy is rated on a scale from 1 to 6, and the expectancy rating varies linearly with the indicator value as shown in Figure 9. The expectancy rating form can be found in the FHWA report for further reference.

Table 7 is the computer generated ranking of sites based on this indicator.

TABLE 7. SITE RANKING BY DRIVER EXPECTANCY

RANK NUMBER	INTERSECTION LOCATION	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	JELLISON ROAD CURVE	NA	NA	6	4	5.3	89
2	KING AVE & 32ND STREET W	4	2	5	6	4.9	82
3	HIGHWAY 312 & HUNTLEY APP. RD	4	NA	6	3	4.8	81
4	OLD HARDIN RD & PICCOLO LN	3	5	6	3	4.8	80
5	COBURN RD & ROSEBUD LANE	4	2	NA	6	4.7	78
6	DANFORD RD & 56TH STREET W	2	4	5	5	4.5	75
7	SHEPHERD RD & SHEPHERD RD E	5	5	3	3	4.4	73
8	DOVER RD & PIONEER RD	NA	4	5	3	4.3	72
9	HIGHWAY 312 & SHEPHERD RD	4	3	5	4	4.3	72
10	OLD HARDIN RD & BECRAFT LN	5	2	4	4	4.2	70
11	HIGHWAY 312 & BARRY RD	NA	3	5	3	4.0	67
12	HIGHWAY 10 E & GOLF COURSE RD	4	5	2	2	3.8	63
13	HIGHWAY 312 & DRURY LANE	4	4	3	3	3.7	62
14	HIGHWAY 312 & McGIRL RD	3	4	4	3	3.7	62
15	NEIBAUR ROAD CURVE	NA	NA	4	3	3.7	61
16	OLD HARDIN RD & DICKIE RD	NA	3	4	NA	3.7	61
17	GRAND AVE & 54TH STREET W	NA	5	2	2	3.5	58
18	12 MILE RD & HOMER DAVIS RD	2	4	3	2	3.1	52
19	HIGHWAY 312 & DOVER RD	4	2	2	3	3.1	52
20	SHEPHERD RD & CHICAGO RD	2	2	3	3	3.0	50
					AVERAGE INDICATOR VALUE =		67.9

7. Information System Deficiencies Indicator - This indicator also provides a value or subjective judgement on the sufficiency of traffic control devices which transfer necessary information to the operator.

The data format for the information system deficiencies indicator is similar to that of the driver expectancy indicator in that a value form is used to provide a rating between 1 and 6. The rating for this indicator is also plotted linearly between the indicator range values of 0 and 100 and is shown on Figure 10. The value rating form is for the information system deficiencies indicator. It is also presented in the FHWA report for further

reference.

Table 8 is the computer generated ranking of sites based on this indicator.

TABLE 8. SITE RANKING BY INFORMATION DEFICIENCY

RANK NUMBER	INTERSECTION LOCATION	NB RATE	SB RATE	EB RATE	WB RATE	WGTD. RATE	IND VAL
1	COBURN RD & ROSEBUD LANE	6	4	NA	6	5.7	94
2	JELLISON ROAD CURVE	NA	NA	6	5	5.7	94
3	DANFORD RD & 56TH STREET W	3	6	5	6	5.5	92
4	HIGHWAY 312 & HUNTLEY APP. RD	6	NA	5	5	5.5	92
5	OLD HARDIN RD & BECRAFT LN	5	4	6	4	5.1	85
6	SHEPHERD RD & SHEPHERD RD E	5	6	3	4	5.0	83
7	HIGHWAY 312 & McGIRL RD	5	5	4	4	4.7	78
8	NEIBAUR ROAD CURVE	NA	5	4	NA	4.7	78
9	KING AVE & 32ND STREET W	4	3	5	5	4.6	77
10	GRAND AVE & 54TH STREET W	NA	5	4	4	4.5	75
11	HIGHWAY 312 & BARRY RD	NA	4	5	4	4.5	75
12	OLD HARDIN RD & PICCOLO LN	NA	4	5	4	4.5	75
13	HIGHWAY 10 E & GOLF COURSE RD	5	5	3	3	4.4	73
14	HIGHWAY 312 & DOVER RD	5	3	4	4	4.3	72
15	DOVER RD & PIONEER RD	NA	4	5	2	4.2	69
16	HIGHWAY 312 & SHEPHERD RD	4	3	5	3	4.1	68
17	12 MILE RD & HOMER DAVIS RD	4	4	3	3	3.7	62
18	HIGHWAY 312 & DRURY LANE	4	4	3	3	3.7	62
19	OLD HARDIN RD & DICKIE RD	NA	4	2	NA	3.3	56
20	SHEPHERD RD & CHICAGO RD	3	3	3	3	3.0	50
					AVERAGE INDICATOR VALUE =		75.5

HAZARD RANKING

Once all of the data had been collected and the indicator values computed, indicator values and necessary data are transferred to the hazard index computation matrix. Each indicator is weighted in accordance with the FHWA report. The weighting factors are fractional portions of unity. When all nine indicators established in FHWA report are used, the sum of weights is equal to one. In the case of Yellowstone County, two indicators were omitted, the Traffic Conflict Indicator and the Erratic Maneuvers Indicator. Their exclusion from the study was not felt to be any deterrent in the ranking of hazardous sites. The use of seven indicators provides an 88.6% confidence of strength of evaluation.

Based on the hazard analysis for each site, a matrix of indicator values and final hazard index ratings was constructed on the Lotus system a hazard index ranking was completed. Table 9 lists this ranking by site number, location, indicator values and hazard index. Also shown is statistical information for the indicator values and hazard index.

During the process of field data collection and subsequent indicator computations, it was discovered that the two entirely subjective indicators could vary widely between consecutive analyses among non-experienced observers. Yellowstone County will most likely retain traffic personnel who will update the high hazard priority list and therefore these indicators should remain as part of the hazard index ranking.

TABLE 9. SITE RANKING BY HAZARD INDEX VALUES - SUMMARY OF INDICATOR VALUES

RANK NUMBER	INTERSECTION LOCATION	# OF ACC. IND VAL	# OF ACC. PART H.I.	ACC. RATE IND VAL	ACC. RATE PART H.I.	SEVERITY IND VAL	SEVERITY PART H.I.	V/C RATIO IND VAL	V/C RATIO PART H.I.	SIGHT DIST IND VAL	SIGHT DIST PART H.I.	EXPECT. IND VAL	EXPECT. PART H.I.	INFO DEF. IND VAL	INFO DEF. PART H.I.	TOTAL HAZARD INDEX
	* RELATIVES WEIGHTS :	0.163		0.224		0.190		0.082		0.074		0.148		0.115		275
1	DOVER ROAD & PIONEER ROAD	54	8.80	100	22.40	66	12.54	11	0.90	100	7.40	72	10.66	69	7.94	70.64
2	JELLISON ROAD CURVE	58	9.45	50	11.20	77	14.63	31	2.54	100	7.40	89	13.17	94	10.81	69.21
3	SHEPHERD RD & SHEPHERD RD E	71	11.57	71	15.90	62	11.78	39	3.20	85	6.29	73	10.80	83	9.55	69.09
4	COBURN ROAD & ROSEBUD LANE	57	9.29	83	18.59	40	7.60	31	2.54	100	7.40	78	11.54	94	10.81	67.78
5	DANFORD RD & 56TH STREET W	54	8.80	77	17.25	64	12.16	24	1.97	59	4.37	75	11.10	92	10.58	66.22
6	OLD HARDIN ROAD & BECRAFT LANE	81	13.20	52	11.65	62	11.78	41	3.36	82	6.07	70	10.36	85	9.78	66.20
7	OLD HARDIN RD & DICKIE RD	58	9.45	92	20.61	58	11.02	21	1.72	100	7.40	61	9.03	56	6.44	65.67
8	GRAND AVE & 54TH STREET W	71	11.57	74	16.58	67	12.73	29	2.38	56	4.14	58	8.58	75	8.63	64.61
9	HIGHWAY 312 & HUNTLEY APP RD	54	8.80	39	8.74	71	13.49	30	2.46	56	4.14	81	11.99	92	10.58	60.20
10	SHEPHERD ROAD & CHICAGO ROAD	69	11.25	78	17.47	68	12.92	29	2.38	39	2.89	50	7.40	50	5.75	60.05
11	HIGHWAY 312 - McGIRL ROAD	71	11.57	35	7.84	74	14.06	41	3.36	43	3.18	62	9.18	78	8.97	58.16
12	KING AVENUE W & 32ND STREET W	83	13.53	33	7.39	43	8.17	60	4.92	23	1.70	82	12.14	77	8.86	56.70
13	HIGHWAY 10E - GOLF COURSE RD	54	8.80	56	12.54	64	12.16	23	1.89	46	3.40	63	9.32	73	8.40	56.52
14	12 MILE RD & HOMER DAVIS RD	45	7.34	83	18.59	68	12.92	16	1.31	5	0.37	52	7.70	62	7.13	55.36
15	HIGHWAY 312 - SHEPHERD ROAD	64	10.43	37	8.29	63	11.97	41	3.36	37	2.74	72	10.66	68	7.82	55.27
16	HIGHWAY 312 & DRURY LANE	57	9.29	21	4.70	86	16.34	45	3.69	47	3.48	62	9.18	62	7.13	53.81
17	OLD HARDIN RD & PICCOLO LANE	69	11.25	23	5.15	44	8.36	59	4.84	49	3.63	80	11.84	75	8.63	53.69
18	HIGHWAY 312 & DOVER RD	77	12.55	30	6.72	62	11.78	51	4.18	26	1.92	52	7.70	72	8.28	53.13
19	NIEBAUR ROAD CURVE	50	8.15	27	6.05	73	13.87	34	2.79	34	2.52	61	9.03	78	8.97	51.37
20	HIGHWAY 312 & BARRY ROAD	64	10.43	23	5.15	63	11.97	45	3.69	11	0.81	67	9.92	75	8.63	50.60
	AVERAGE VALUES :	63.0	10.27	54.2	12.14	63.7	12.11	35.0	2.87	54.9	4.06	68	10.06	75.5	8.68	60.21
	STANDARD DEVIATIONS :	10.1	1.66	24.2	5.43	11.6	2.21	13.1	1.07	28.3	2.10	10.7	1.59	13.0	1.50	5.79

* SINCE 2 CONFLICT INDICATORS WERE OMMITTED FROM THE PROCEDURE, THE PUBLISHED WEIGHT FACTORS WERE DIVIDED BY .886 TO ADJUST FOR THE RELATIVE STRENGTH OF EVALUATION.

EXPLANATION OF IMPROVEMENTS

The recommended improvements presented within this report are of two types. Short term improvements indicate the minimum amount of upgrading or modifications necessary to increase driver expectancy and to update the site to current standards. Long term improvements are normally considered viable when severe conditions at the site prevent short term improvements from completely satisfying the control measures necessary to prevent future problems. Since all of the long term improvements are dependant upon significant changes in the future operations, no costs or project ranking was completed. Many of the recommended improvements have sufficient latitude so that alternative measures could be suggested during design. The selection of recommended improvements was based on subjective engineering judgement.

At numerous sites it was noted that many traffic control devices were not in compliance with MUTCD. There were also several locations where deficiencies may be critical and should be corrected as soon as possible. In some cases the recommended improvements will require precise layout in the field. In addition, an experienced traffic engineer is required to coordinate other phases of the recommended improvements.

The improvement sketches in all cases should not be considered design plans. Those drawings are preliminary and are intended to present the improvement concepts only in enough detail to provide a general ideal of the costs which could be anticipated. In some cases, detailed survey data and design research will be necessary prior to preparation of final plans.

BENEFIT/COST RATIOS

Costs - are developed by preliminary estimation of required quantities based on current prices as tabulated from average bid prices of similar projects. The costs should in no way be considered a quote or final estimate of actual work.

Even though Yellowstone County maintenance crews are capable of performing a good deal of work, the costs are based on contract prices in order to correlate with costs requiring contract bid letting. The costs do not include administrative, engineering or field layout for the recommended improvements which would require bid letting. Engineering design will generally be required to produce contract plans and specifications. These costs should be evaluated prior to planning improvement projects.

Benefits - are estimated by applying accident reduction forecasts based on the type of improvement recommended. The forecasts are based on the subjective evaluation by an experienced traffic engineer. This evaluation is aided by knowledge of accident experience at similar intersections with the improvements existing. Also statistical studies relating certain improvements to accident reduction are used as a guide ie, Roy Jorgenson and Associates, "Evaluation of Criteria for Safety Improvements on the Highway" (Washington, D.C.: U.S. Bureau of Public Roads, Office of Highway Safety, 1966. p. 316).

The forecasted reduction is expressed as a percentage of each type of accident. This percentage is multiplied by the percentage of all accidents represented by each type. The total percent reduction

of all accidents at each site is the sum of all accidents reduction percentages for each type.

The method used to compute benefits in this study follows the Montana Department of Highways procedures. Those procedures were programmed for the Lotus 123 Computer Software which provides a tabular summary of all variables in the computation.

If applied consistently, the economic benefit computation will provide a realistic estimate of average economic savings to the general society. The benefit amount should not be interpreted as a dollar value that Yellowstone County will receive as a result of dollar outlay. It is a figure used to quantify the economic benefit to society that would occur if a certain number of accidents did not occur.

Ratio - of benefits to cost provides a reference as to the value of the recommended improvements. It is the desire of any improvement project to have a benefit-cost (B/C) ratio in excess of 1.0. If the B/C is less than 1.0 the project would have questionable justification. In this study all of the projects have a B/C greater than 1.0. Table 10 is a computer generated summary of the B/C ranking for the twenty sites.

It should be noted that the King Ave. W. & 32nd St. W. site is ranked number 18. The full cost of improvement was used to calculate the B/C ratio. If only the cost to Yellowstone County were used, the B/C ratio would be 2.26 and that intersection would rank 14th out of 20.

TABLE 10. SITE RANKING BY BENEFIT/COST RATIOS - CALCULATION SUMMARY

			C O S T S						B E N E F I T S							
#	SITE LOCATION	*PROJ LIFE	CAPITOL COST IMPROVE	EQUIV ANNUAL COST	ANNUAL MAINT. COST CH.	TOTAL ANNUAL COST	ADTa ---- ADTb	I/F	@	A/i	Apd	PFI	Ppd	ANNUAL BENEFIT	B/C RATIO	IND VAL
1	SHEPHERD RD & CHICAGO RD	5	$1,300	$388	200	$588	1.1	17	$20,109	2	1	53%	18%	$17,752	30.20	100
2	GRAND AVE & 54TH ST. W.	5	$900	$268	200	$468	1.1	17	$20,109	1	2	70%	63%	$9,570	20.43	100
3	HIGHWAY 10E & GOLF COURSE RD	5	$2,000	$597	200	$797	1.0	17	$20,109	1	1	63%	30%	$10,052	12.62	100
4	12 MILE RD & HOMER DAVIS RD	5	$1,300	$388	200	$588	1.0	17	$20,109	1	1	38%	50%	$4,160	7.08	85
5	OLD HARDIN RD & PICCOLO LANE	10	$8,700	$1,733	500	$2,233	1.2	25	$16,346	1	2	54%	43%	$14,475	6.48	81
6	HIGHWAY 312 & SHEPHERD RD	7	$6,400	$1,538	200	$1,738	1.1	17	$20,109	1	2	53%	47%	$10,145	5.84	76
7	OLD HARDIN RD & BECRAFT LANE	5	$9,900	$2,953	800	$3,753	1.1	25	$16,346	1	3	66%	59%	$17,315	4.61	66
8	NEIBAUR ROAD CURVE	10	$19,400	$3,865	300	$4,165	1.1	17	$20,109	1	0	80%	80%	$18,015	4.32	64
9	HIGHWAY 312 & DOVER RD	10	$16,700	$3,328	200	$3,528	1.2	17	$20,109	2	2	23%	44%	$12,370	3.51	54
10	OLD HARDIN RD & DICKIE RD	5	$2,400	$716	800	$1,516	1.0	17	$20,109	0	2	70%	64%	$4,934	3.25	51
11	HIGHWAY 312 & BARRY RD	5	$7,800	$2,327	200	$2,527	1.1	17	$20,109	1	1	33%	26%	$7,621	3.02	48
12	SHEPHERD RD & SHEPHERD RD E	15	$30,800	$5,267	800	$6,067	1.3	17	$20,109	1	2	58%	48%	$16,983	2.80	45
13	HIGHWAY 312 & McGIRL RD	10	$14,600	$2,909	400	$3,309	1.2	17	$20,109	1	2	28%	56%	$8,303	2.51	40
14	JELLISON ROAD CURVE	15	$16,600	$2,839	500	$3,339	1.2	17	$20,109	0	2	80%	67%	$6,232	1.87	27
15	DOVER RD. & PIONEER RD.	15	$28,000	$4,788	200	$4,988	1.1	17	$20,109	1	1	70%	60%	$8,327	1.67	22
16	HIGHWAY 312 & DRURY LANE	10	$30,400	$6,057	400	$6,457	1.2	17	$20,109	1	1	34%	35%	$10,643	1.65	21
17	DANFORD RD & 56TH ST. W.	5	$2,800	$835	200	$1,035	1.0	17	$20,109	0	1	10%	74%	$1,606	1.55	19
18	KING AVE W.-32ND ST. W.	15	$217,000	$37,111	$2,000	$39,111	2.0	25	$16,346	2	8	58%	36%	$44,294	1.13	6
19	COBURN RD & ROSE BUD LANE	10	$14,800	$2,949	600	$3,549	1.1	25	$16,346	0	2	60%	67%	$3,977	1.12	5
20	HIGHWAY 312 & HUNTLEY APP	10	$21,300	$4,244	400	$4,644	1.2	17	$20,109	0	1	60%	58%	$4,684	1.01	1
	TOTALS :		$453,100	$85,102	$9,300	$94,402								$231,459		
	AVERAGES :	8.8	$22,655	$4,255	$465	$4,720								$11,573	5.83	50.5

COMPOUNDED INTEREST RATE : 15%
COST OF FATAL ACCIDENT : $210,000 (1983 NATIONAL SAFETY COUNCIL DATA)
COST OF INJURY ACCIDENT : $8,600
COST OF PROPERTY DAMAGE ACCIDENT ; $1,150
I/F RATIO URBAN : 25.0
I/F RATIO RURAL : 16.5

* Project Life is based on a combination of aggregate lives, ie. Sign Life = 5 years
Const Life=20 years

PRIORITY INDEX

The ranking of site improvement priorities cannot be directly dependent on the hazard ranking of the twenty sites. The value of the improvements must enter into the priority listing in the form of the benefit / cost ratio (B/C). The method of developing a composite Hazard Index - B/C listing must not be dependent on the number of locations studied. Therefore, a correlation of scale between the B/C ratio and hazard indicator value was developed on the following assumptions:

1. The contributing conditions creating hazards at each site and the resulting hazard ranking is relatively independent of the cost of correcting these conditions.

2. Benefits to be derived from the correcting hazardous situations at each site is indirectly proportional to the degree of hazardness.

3. The benefit-cost ratio by virtue of benefit computation is indirectly proportional to the number of accidents indicator and severity indicator, both of which are curvilinear functions.

4. The benefit-cost ratios can be rated on a scale of 0 to 100 based on a curvilinear function.

5. The B/C ratio of 1.0 is equivalent to an indicator value of 0 and the upper limit (indicator value = 100) must be chosen to encompass the majority of sites. In this case a B/C of 10.0 assumes the indicator value of 100.

Based on these assumptions a graphic plot of the B/C ratio versus B/C indicator value has been established and it is shown in

Figure 11. Since it has been graphed on semi-log paper the line appears linear.

Since the relative weighting of benefit-costs and hazardness is a controversial subject which would require research beyond the scope of this report, it is felt that the priority index should be based on 33% weighting for the benefit-cost ratio and 67% weight on the hazard index. Therefore, to establish a priority index the following formula has been devised:

$$\text{Priority Index} = (\text{Hazard Index}) \times (0.67) + (\text{Cost-Benefit Indicator}) \times (0.33)$$

Table 11 is the computer generated summary of priority ranking based on the composite hazard index - benefit/cost index values.

It should be noted that the priority list contains only short term improvements. Since all long term improvements are major reconstruction projects based on future conditions of volume and use, no priority listing for long term improvements was assembled.

TABLE 11. SITE RANKING BY PRIORITY INDEX - CALCULATION SUMMARY

PRIORITY NUMBER	INTERSECTION LOCATION	HAZARD INDEX	WEIGHTED VALUE	BEN/COST INDEX	WEIGHTED VALUE	PRIORITY INDEX
1	GRAND AVE & 54TH STREET W	64.61	43.29	100	33.00	76.29
2	SHEPHERD ROAD & CHICAGO ROAD	60.05	40.23	100	33.00	73.23
3	HIGHWAY 10E - GOLF COURSE RD	56.52	37.87	100	33.00	70.87
4	OLD HARDIN ROAD & BECRAFT LANE	66.20	44.35	66	21.78	66.13
5	12 MILE RD & HOMER DAVIS RD	55.36	37.09	85	28.05	65.14
6	OLD HARDIN RD & PICCOLO LANE	53.69	35.97	81	26.73	62.70
7	HIGHWAY 312 - SHEPHERD ROAD	55.27	37.03	76	25.08	62.11
8	SHEPHERD RD & SHEPHERD RD E	69.09	46.29	45	14.85	61.14
9	OLD HARDIN RD & DICKIE RD	65.67	44.00	51	16.83	60.83
10	NEIBAUR ROAD CURVE	51.37	34.42	64	21.12	55.54
11	JELLISON ROAD CURVE	69.21	46.37	27	8.91	55.28
12	DOVER ROAD & PIONEER ROAD	70.64	47.33	22	7.26	54.59
13	HIGHWAY 312 & DOVER RD	53.13	35.60	54	17.82	53.42
14	HIGHWAY 312 - McGIRL ROAD	58.16	38.97	40	13.20	52.17
15	DANFORD RD & 56TH STREET W	66.22	44.37	19	6.27	50.64
16	HIGHWAY 312 & BARRY ROAD	50.60	33.90	48	15.84	49.74
17	COBURN ROAD & ROSEBUD LANE	67.78	45.41	5	1.65	47.06
18	HIGHWAY 312 & DRURY LANE	53.81	36.05	21	6.93	42.98
19	HIGHWAY 312 & HUNTLEY APP RD	60.20	40.33	1	0.33	40.66
20	KING AVENUE W & 32ND STREET W	56.70	37.99	6	1.98	39.97
	AVERAGE VALUES :	60.21	40.34	50.55	16.68	57.02
	STANDARD DEVIATIONS :	6.44	4.31	31.96	10.55	10.15

PRIORITY INDEX = (HAZARD IND.x .67) + (BEN/COST IND.x .33)

IMPLEMENTATION

Within Table 12 the priority lists have been arranged in a manner that budget considerations can readily be applied in the decision to proceed with improvements. The priority ranking should be the major consideration in selecting which sites will be receiving funds first. However, when limited funds are available, it may be wise to skip over one or two projects to improve a greater number of sites. The listing assumes that available funds would be in the range of $60,000 annually. This list could be rearranged depending on the actual level of funding.

King Ave. W. & 32nd St. W. is shown to be the last on the list. However, the urgency for improvements to that site have been documented. If it is not improved by the fall of 1986, the potential for severe accidents would be great enough to supersede all other site priorities. For that reason the King-32nd St. intersection may well become the number 1 priority.

TABLE 12. PROJECT PRIORITY LISTING
SHORT TERM IMPROVEMENTS SCHEDULE

PRIORITY NUMBER	INTERSECTION LOCATION	1985 EST CAPITAL COST	*YEAR OF IMPROVE COST	ACCUMULATED PROGRAM COSTS
1	GRAND AVE & 54TH STREET W	$900	$900	**
2	SHEPHERD ROAD & CHICAGO ROAD	$1,300	$1,300	**
3	HIGHWAY 10E - GOLF COURSE RD	$2,000	$2,000	**
4	OLD HARDIN ROAD & BECRAFT LANE	$9,900	$9,900	
5	12 MILE RD & HOMER DAVIS RD	$1,300	$1,300	**
6	OLD HARDIN RD & PICCOLO LANE	$8,700	$8,700	
7	HIGHWAY 312 - SHEPHERD ROAD	$6,400	$6,400	**
8	SHEPHERD RD & SHEPHERD RD E	$30,800	$30,800	
9	OLD HARDIN RD & DICKIE RD	$2,500	$2,625	**
	RECOMMENDED 1985-1986 BUDGET =		$63,925	$63,925
10	NEIBAUR ROAD CURVE	$19,400	$20,370	
11	JELLISON ROAD CURVE	$16,600	$17,430	
12	DOVER ROAD & PIONEER ROAD	$28,000	$29,400	
	RECOMMENDED 1986-1987 BUDGET =		$67,200	$131,125
13	HIGHWAY 312 & DOVER RD	$16,700	$18,412	
14	HIGHWAY 312 - McGIRL ROAD	$14,600	$16,097	
15	DANFORD RD & 56TH STREET W	$2,800	$3,087	**
16	HIGHWAY 312 & BARRY ROAD	$7,800	$8,600	
17	COBURN ROAD & ROSEBUD LANE	$14,800	$16,317	
	RECOMMENDED 1987-1987 BUDGET =		$62,512	$193,637
18	HIGHWAY 312 & DRURY LANE	$30,400	$35,192	
19	HIGHWAY 312 & HUNTLEY APP RD	$21,300	$24,657	
	RECOMMENDED 1987-1988 BUDGET =		$59,849	
	TOTAL PROGRAM COSTS =	$236,200		$253,486
20	KING AVENUE W & 32ND STREET W	$108,500	SEPERATE PROJECT NOT INCLUDED IN RECOMMENDED SCHEDULE	

* A 5% INFLATIONARY FACTOR IS USED TO COMPUTE COST AT THE YEAR OF IMPROVEMENT

**SIGNIFIES THOSE PROJECTS THAT MAY BE COMPLETED BY COUNTY MAINTENANCE CREWS

PROGRAM CONTINUATION

Since the basic format of the study has been outlined and an initial priority list established, continuance of the program is strongly advised. The findings and recommendations of this study will soon become obsolete without continued updating at least on an annual basis.

The following recommendations in the continuance of the program are offered to Yellowstone County:

1. The Department of Justice should continue to be assessed for copies of accident reports.

2. One person should be assessed with the responsibility of the program to insure that all data is being supplied, processed and filed.

3. An accident cluster map should be maintained.

4. Criteria should be developed for the inclusion of additional sites to be analyzed.

5. Coordinate any traffic counting programs that may exist or establish a counting program.

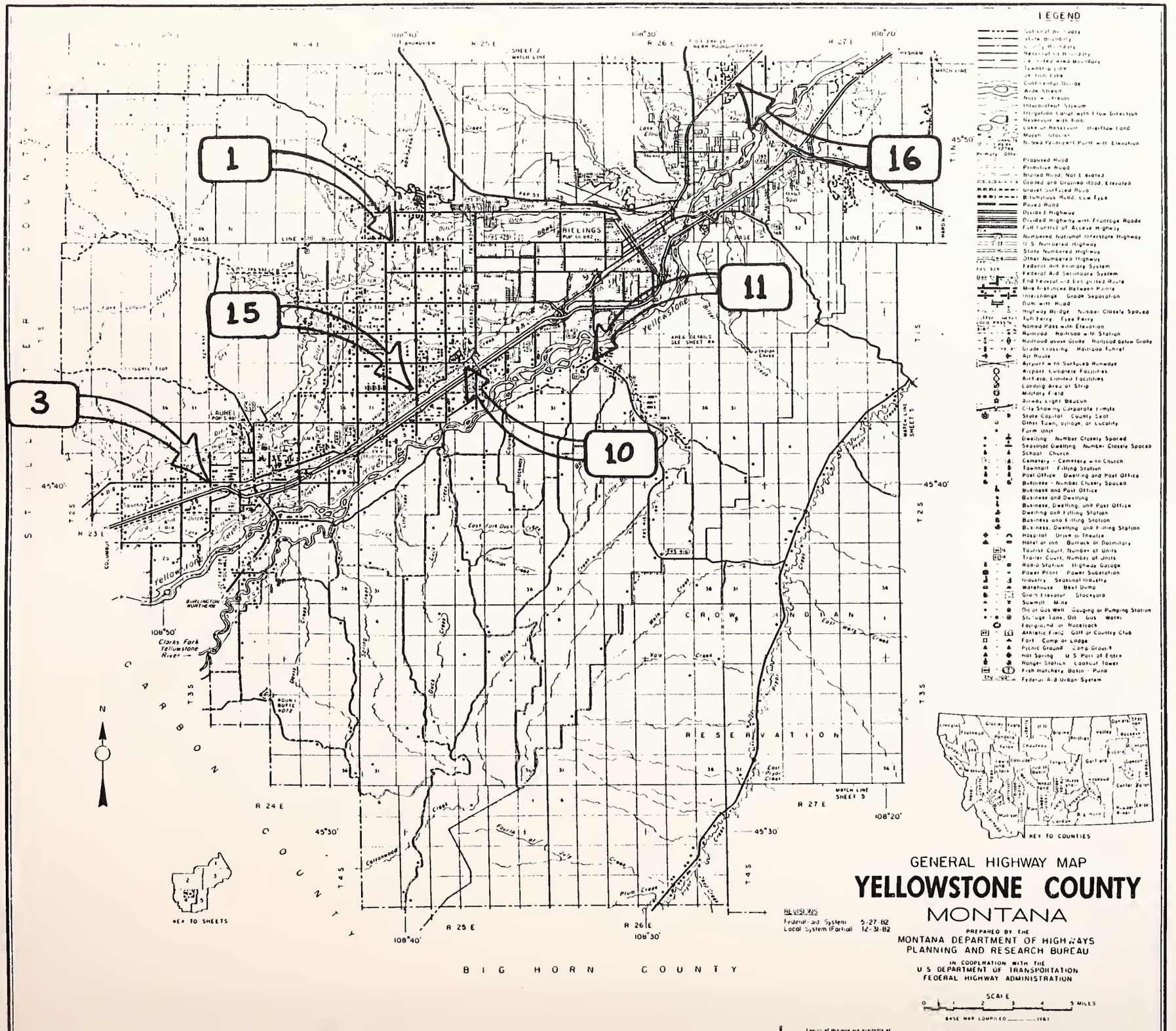
6. Analyze new sites according to the procedures of this study

and include them in the priority list when warranted.

All of the data processing and storage can be handled by the Lotus 123 software. If an IBM compatible computer is available for use by the county, a copy of the data disk can be made.

REPORT

FIGURES



LEGEND

Figure 1a. Site Location Maps

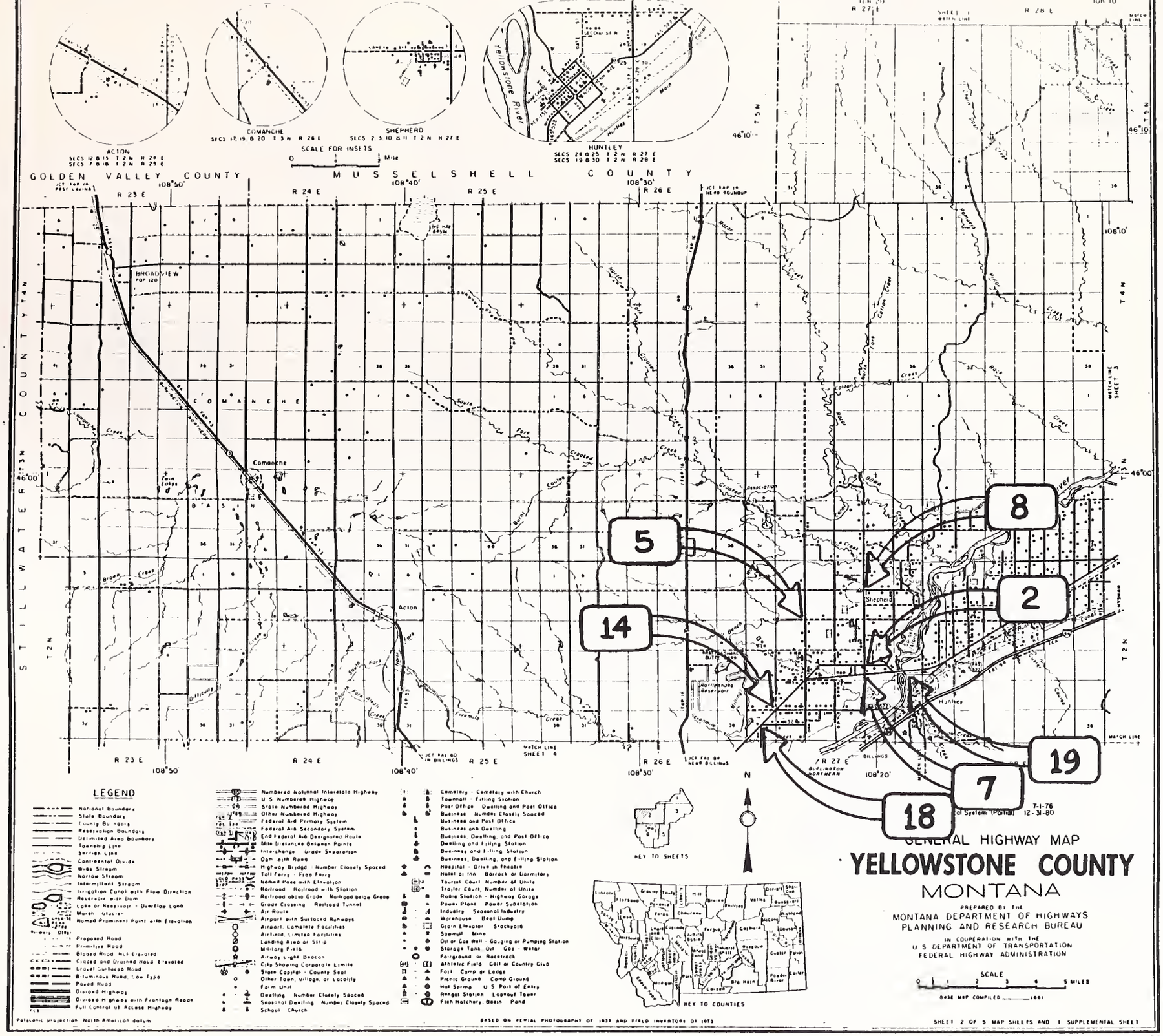


Figure 1b. Site Location Maps

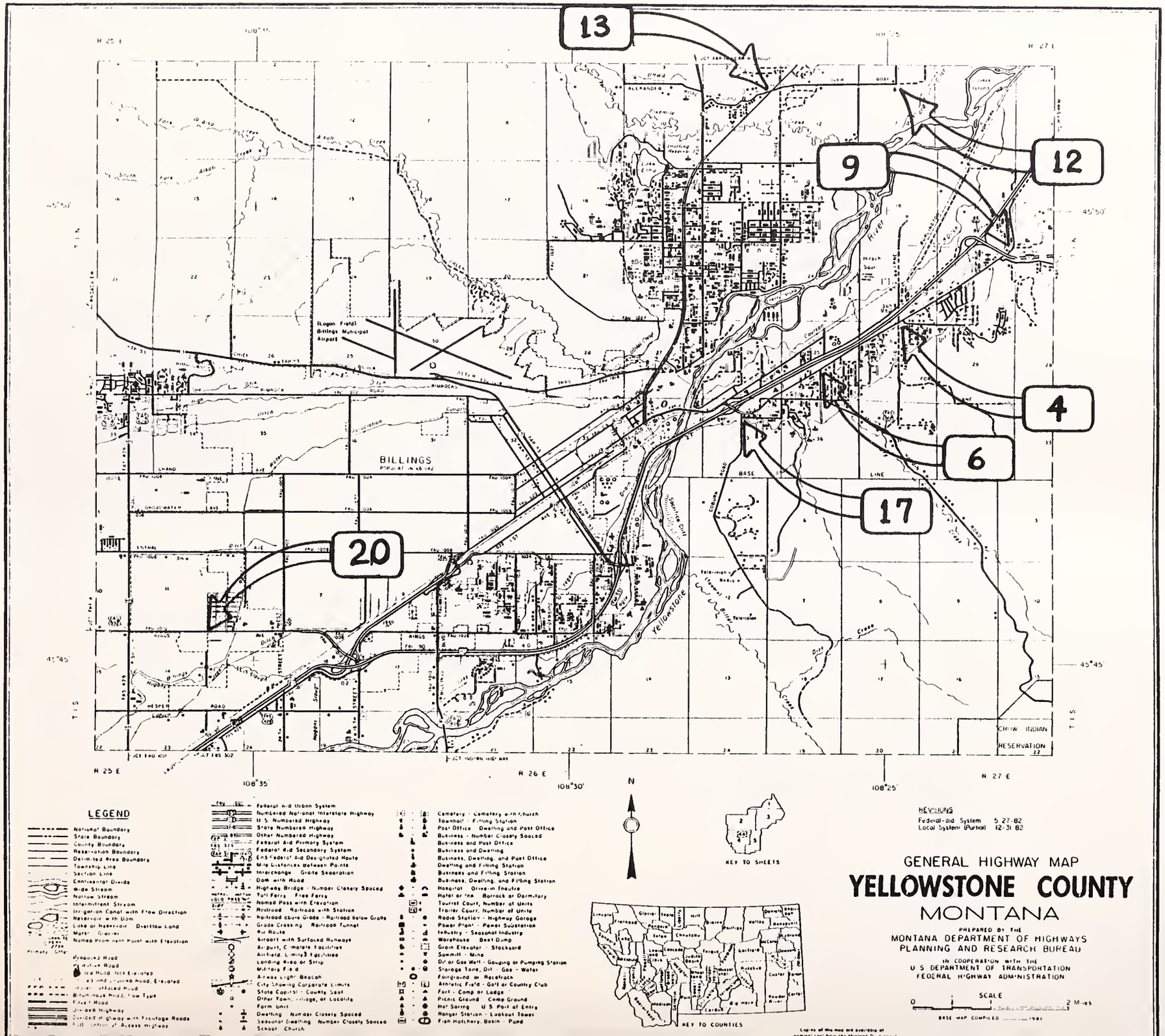


Figure 1c. Site Location Maps

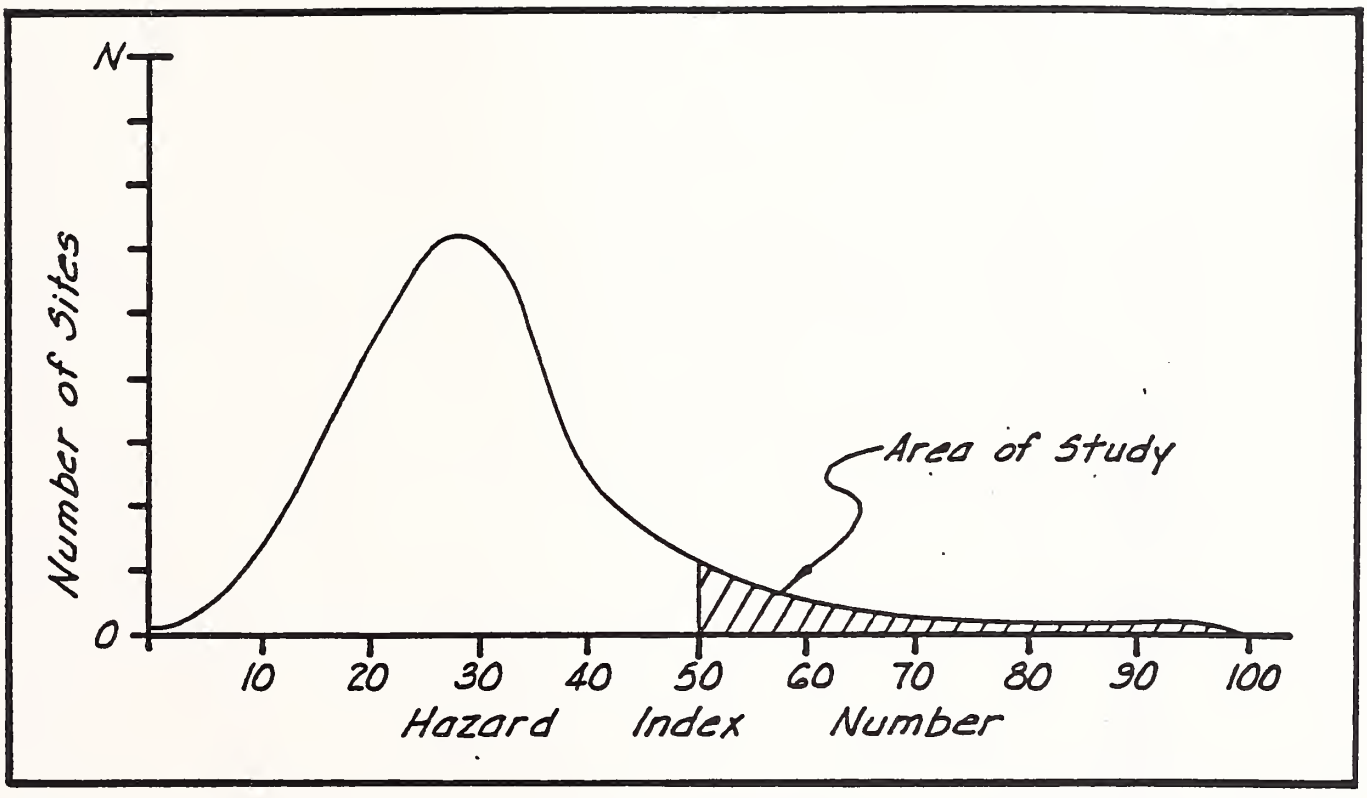


Figure 2. Normal Distribution of 'N' Number of Sites.

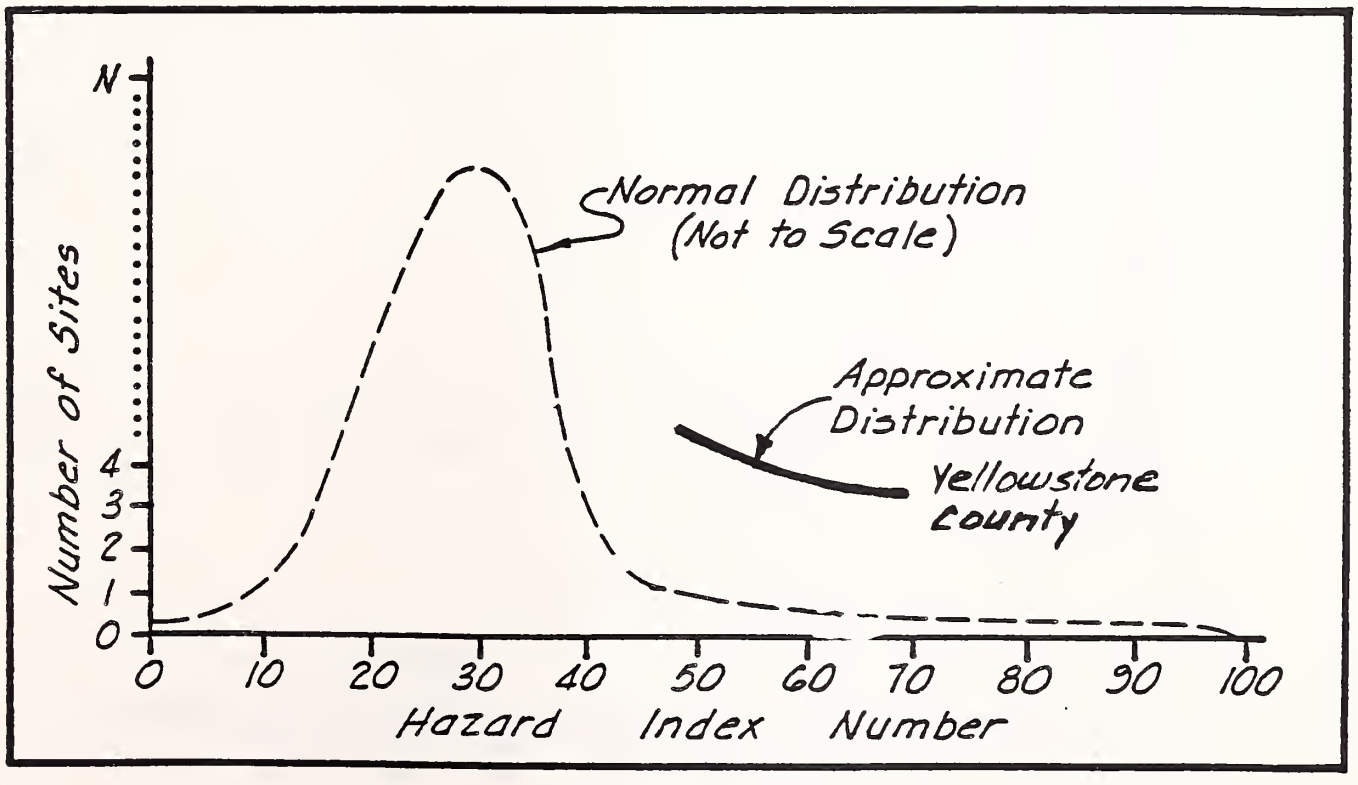


Figure 3. Distribution of Yellowstone County Sites.

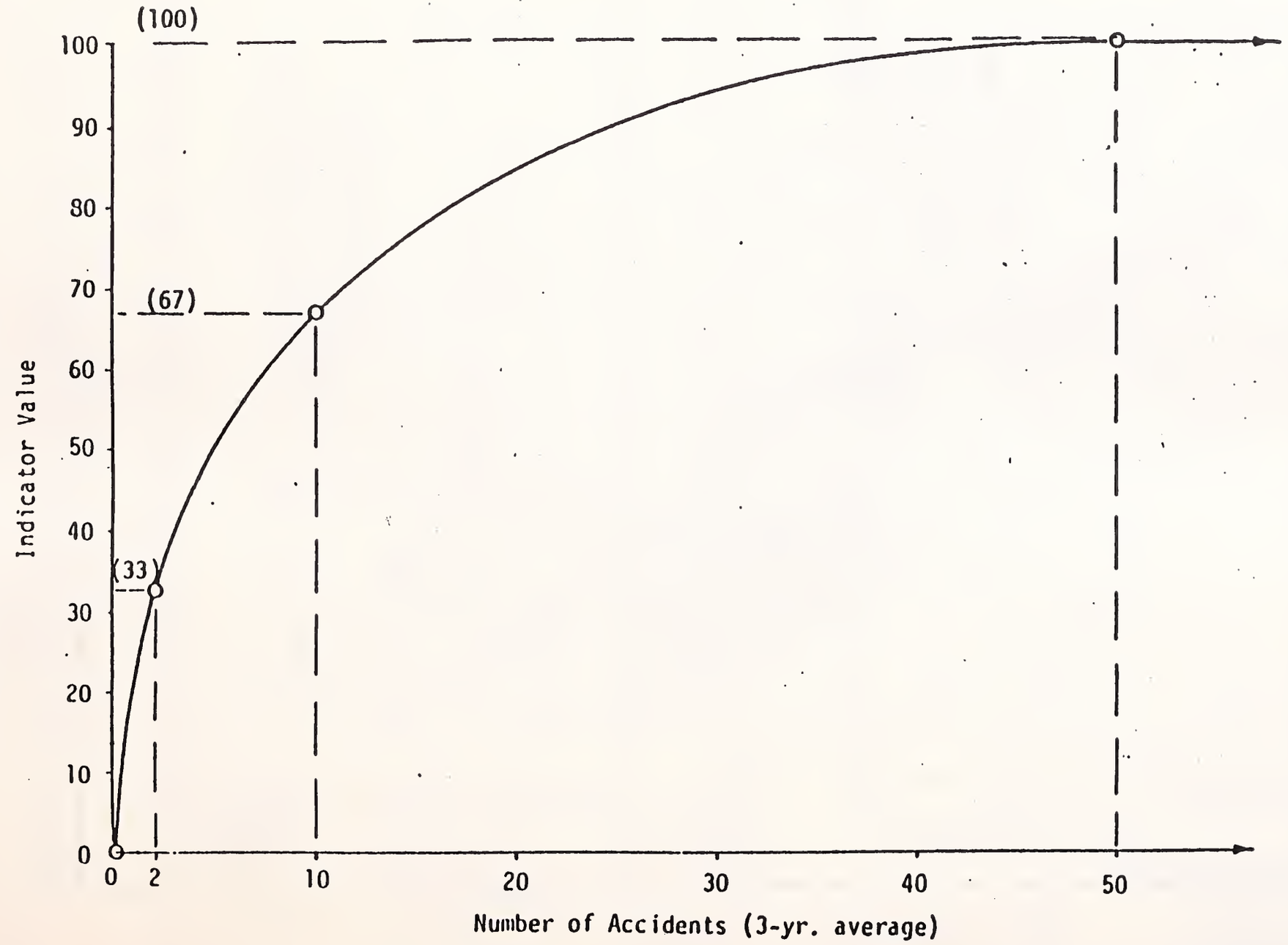


Figure 4. Number of Accidents Indicator

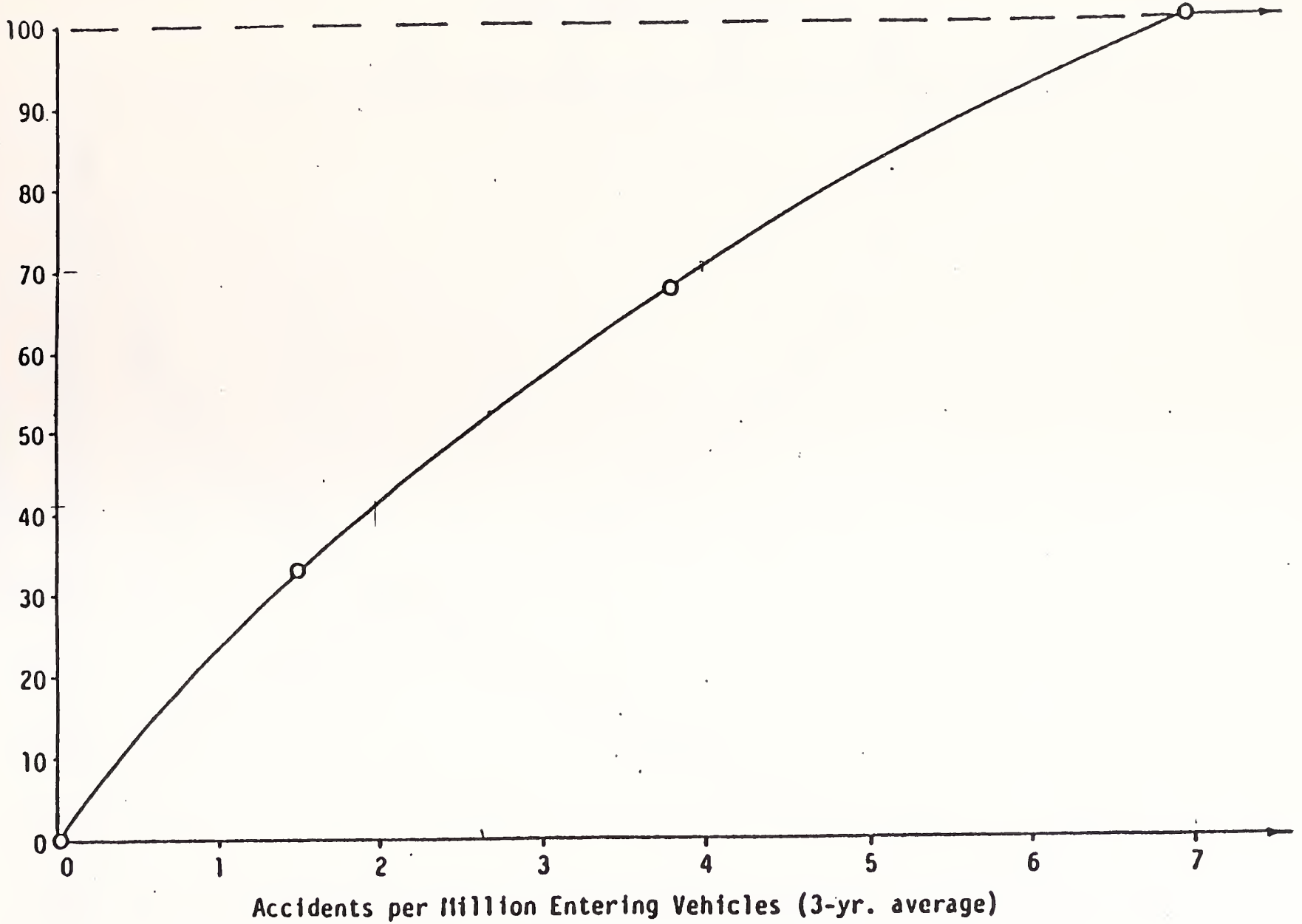


Figure 5. Accident Rate Indicator

Figure 3. Indicator value for accident severity.

Figure 6. Severity Indicator

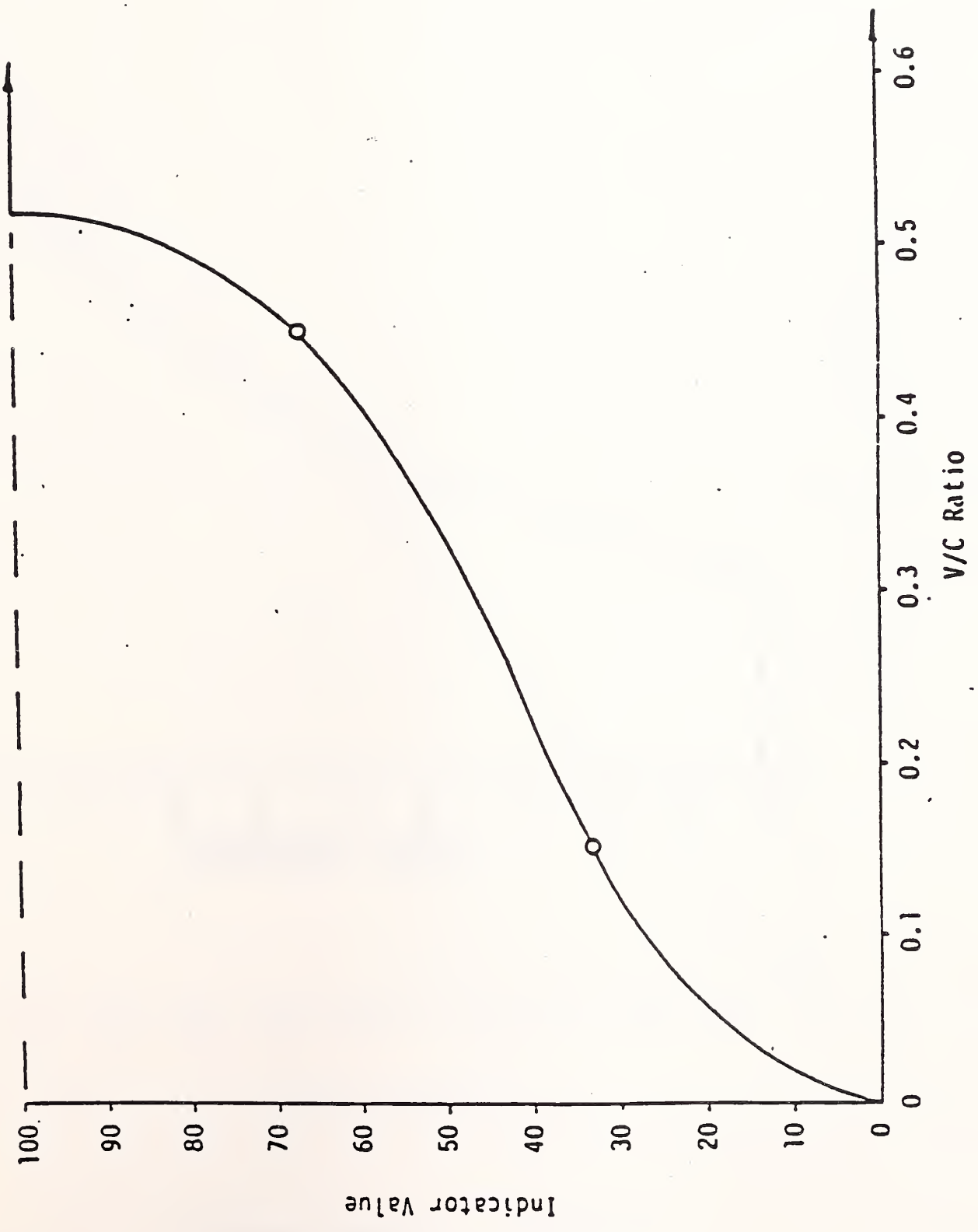


Figure 7. V/C Ratio Indicator

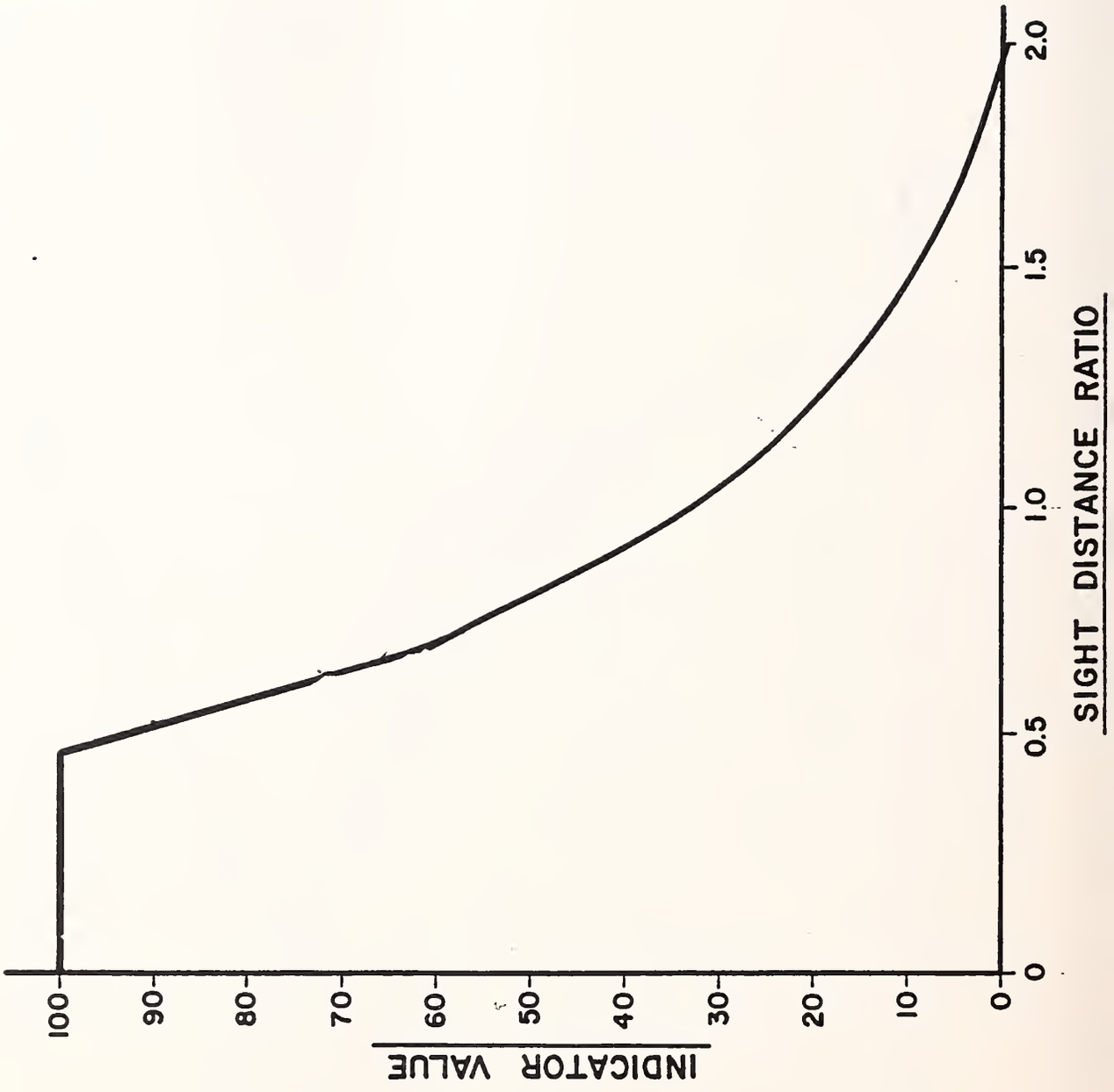


Figure 8. Sight Distance Indicator

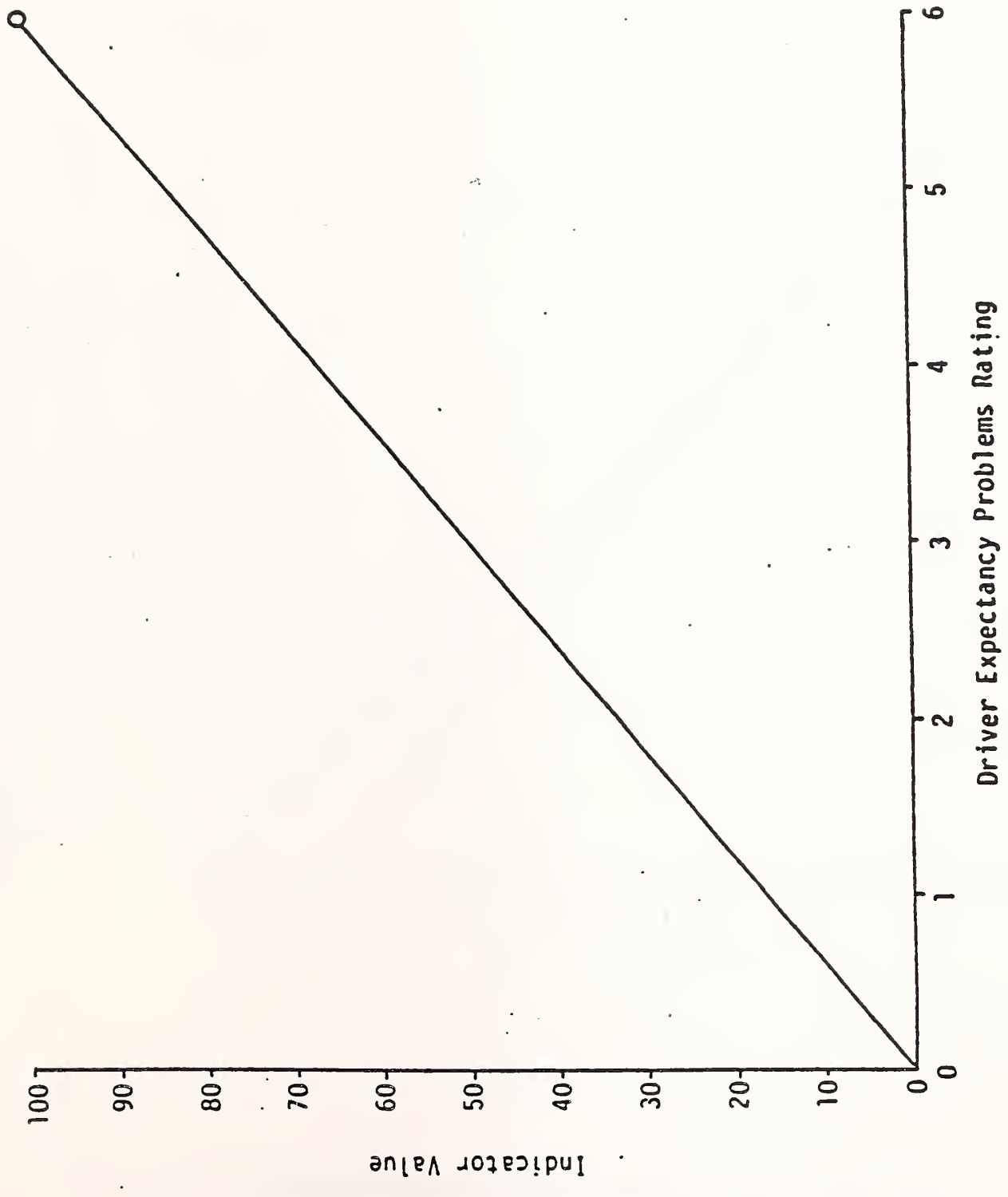


Figure 9. Driver Expectancy Indicator

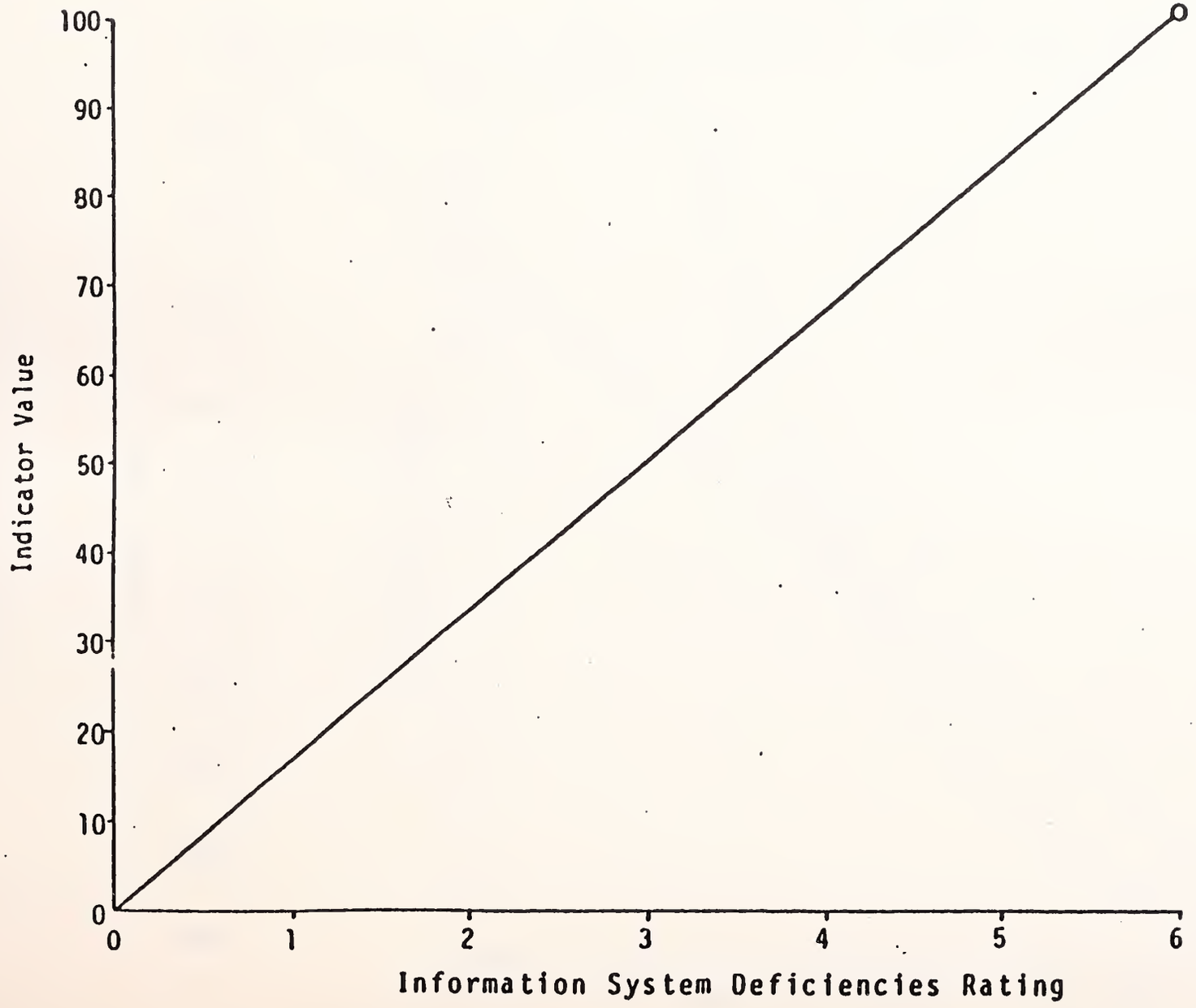


Figure 10. Information Deficiency Indicator

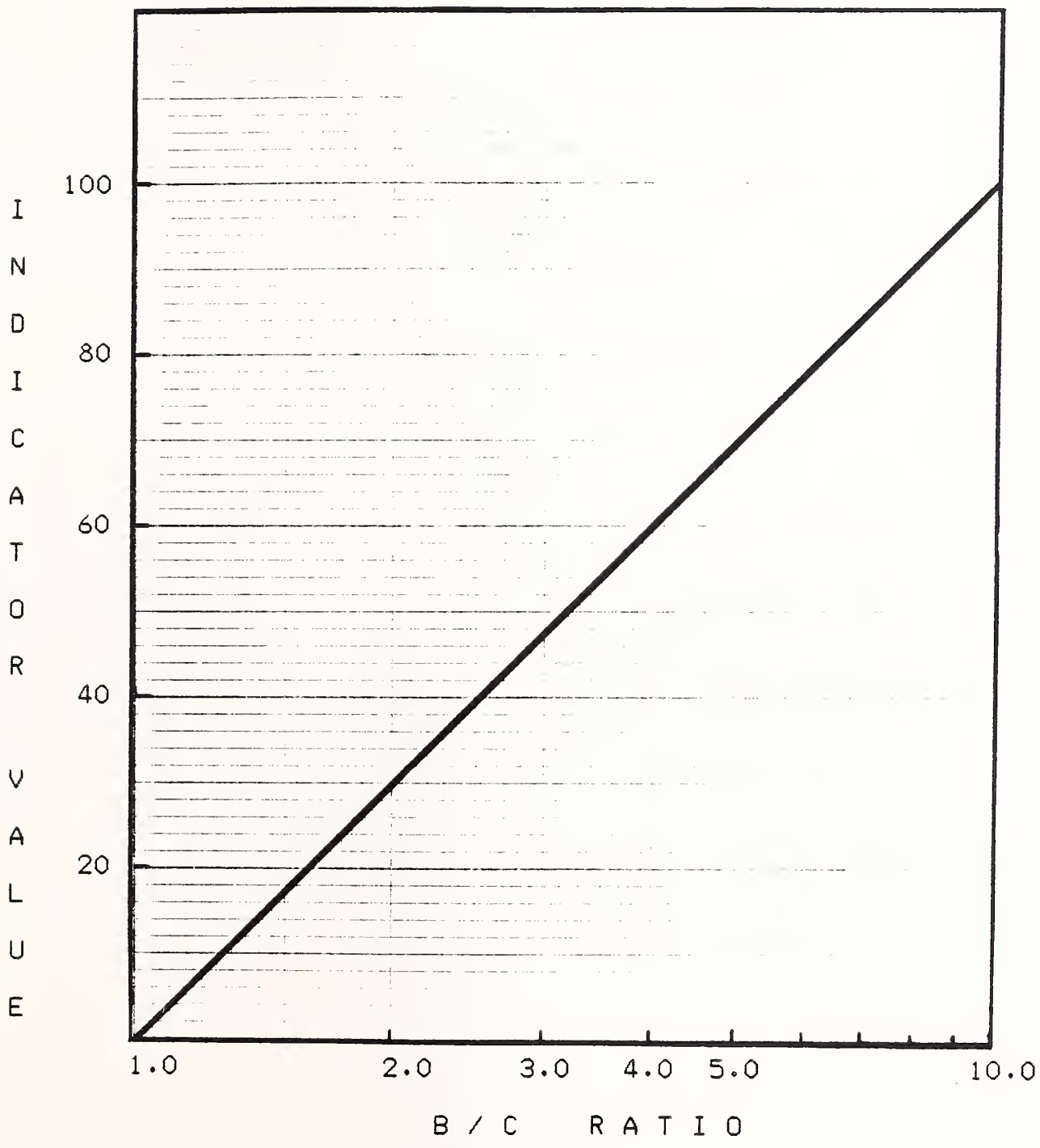


Figure 11. Benefit/Cost Ratio Indicator

#1

GRAND AVENUE - 54TH STREET WEST INTERSECTION

PRIORITY NUMBER 1

SITE DESCRIPTION

Grand Avenue is a Principal Arterial extending from 6th Avenue N. at Division Street in downtown Billings west to a point north of Laurel, Montana. The section between 6th Ave.N. and Rehberg Lane east of the site is in the urban area and carries four lanes of traffic. West of Rehberg on both sides of 54th Street West, it is a two lane rural facility which accommodates both farm and residential subdivision traffic.

Fifty-fourth Street W. is classified as a a local access rural road. It extends from a point .75 miles north of Rimrock Road to Grand Avenue on the south. Although it is only a local road, it serves as a major access link to Grand Avenue from the Yellowstone Country Club Subdivision. Fifty fourth St. W. serves as a collector street for the subdivision north of Rimrock Road. It is heavily used by commuter traffic from the subdivision to Grand Avenue and extreme traffic peaks occur in the morning and evening.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. Approaches to the "T" intersection are less than 1% on Grand and a slightly greater than 1% downgrade on 54th St. West. Roadside ditches are have 2:1 side slopes.

The property in the northeast quadrant of the intersection has large trees in the front yard. These trees and a power pole partially

obscure the line of site from 54th looking east (see photo).

Traffic Control Devices. There appears to have been centerline striping on 54th St. W. at one time. It is barely visible at present. Centerline striping on Grand Avenue does not conform to the standard intersection no passing zones since only dashed yellow lines exists. Fog lines are present on both roadways.

Advanced intersection warning signs are on Grand but they are too small and too close to the intersection for prevailing speeds. The stop sign on 54th becomes lost in the horizon at certain times during the day and it has lost some reflectivity at night.

Traffic Volumes. Peak hour counts were taken during the morning peak since that is the time that the heaviest southbound movements occur and the majority of accidents have been associated with that movement. By applying the appropriate factors it was determined that the average daily traffic is approximately 850 on 54th and 1,600 on Grand.

Traffic Operations. Becuase the majority of accidents occurred during hours of darkness, operations were observed during those hours. It is apparent that the intersection violates driver expectancy and deficient information is provided. The physical features of the intersection are not visible until the vehicle is at the site which leaves no time to react. This deficiency exists for all approaches.

Accidents. There were no reported accidents in 1981 while the remaining years in the four year period had between 3 and 5 accidents per year. The predominant accident involved the southbound movement. Drivers apparently fail to react to the stop condition, overshoot the intersection and come to rest in the irrigation ditch or in the field beyond. These accidents occurred on dry roads which supports the observation that insufficient information is provided to drivers.

As the northern reaches of the Yellowstone Country Club Subdivision becomes more populated, more traffic will traverse the site and therefore more accidents can be expected if improvements are not made at this site.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting mostly of new traffic control devices.

The main purpose of these recommendations is to increase the degree of advanced information which will allow more reaction time. The new stop ahead sign and replacement of the existing stop sign should greatly aid in improving the southbound accident problem. As additional reinforcement, it is recommended that stop ahead pavement markings be added along with the double yellow striping.

To improve information deficiencies on Grand, new intersection warning signs with the supplementary name plates should be located 700 feet from the intersection on both approaches.

The improvements could be installed by County maintenance forces

which would reduce estimated costs. The estimated cost of these improvements is $900.00 based on 1985 unit bid contract prices. This is the lowest cost short term improvement of all 20 accident cluster sites.

Long term improvements cannot be suggested at this point, since the degree of future traffic growth and the construction of alternate access facilities cannot be predicted with any certainty. It is assumed that volumes will not reach a critical stage within the next 10 years. At some future time when volumes stress the safety and capacity of this intersection, a general upgrade would be required on Grand Avenue which would encompass this intersection.

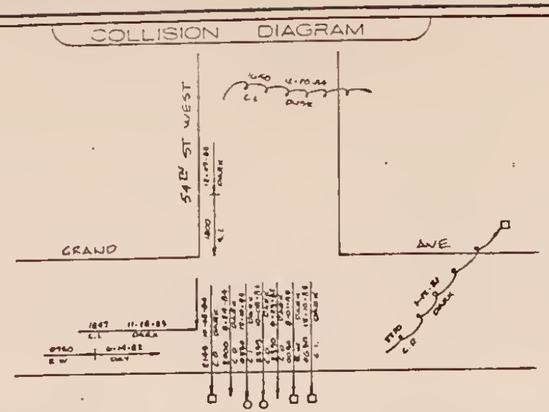
BENEFITS

By improving driver expectancy, the single vehicle accident rate is expected to be reduced by up to 70% while other types of accidents would be improved by approximately 50%. The net benefit according to stated methods would be approximately $ 9,600 annually. The low cost of improvements compared to the relatively high benefit value yields a benefit/cost ratio of 20.43.

FUNDING CONSIDERATIONS

It is recommended that this project lead the list of projects to be completed by either a special annual program or by existing the existing county road fund. Regardless of the source, this project has such a low cost and high B/C ratio that it should be implemented immediately.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C=CLEAR, F=FOG, R=RAIN, S=SNOW, SL=SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D=DRY, W=WET, I=ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT PAVEMENT
FIXED OBJECT	LEFT TURN	
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 0
- 1982= 5
- 1983= 4
- 1984= 3

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 1 ANGLE = 8%
- 0 LEFT TURN= 0%
- 0 SIDE SWP.= 0%
- 2 REAR END = 17%
- 9 SINGLE V = 75%
- 0 OTHER = 0%

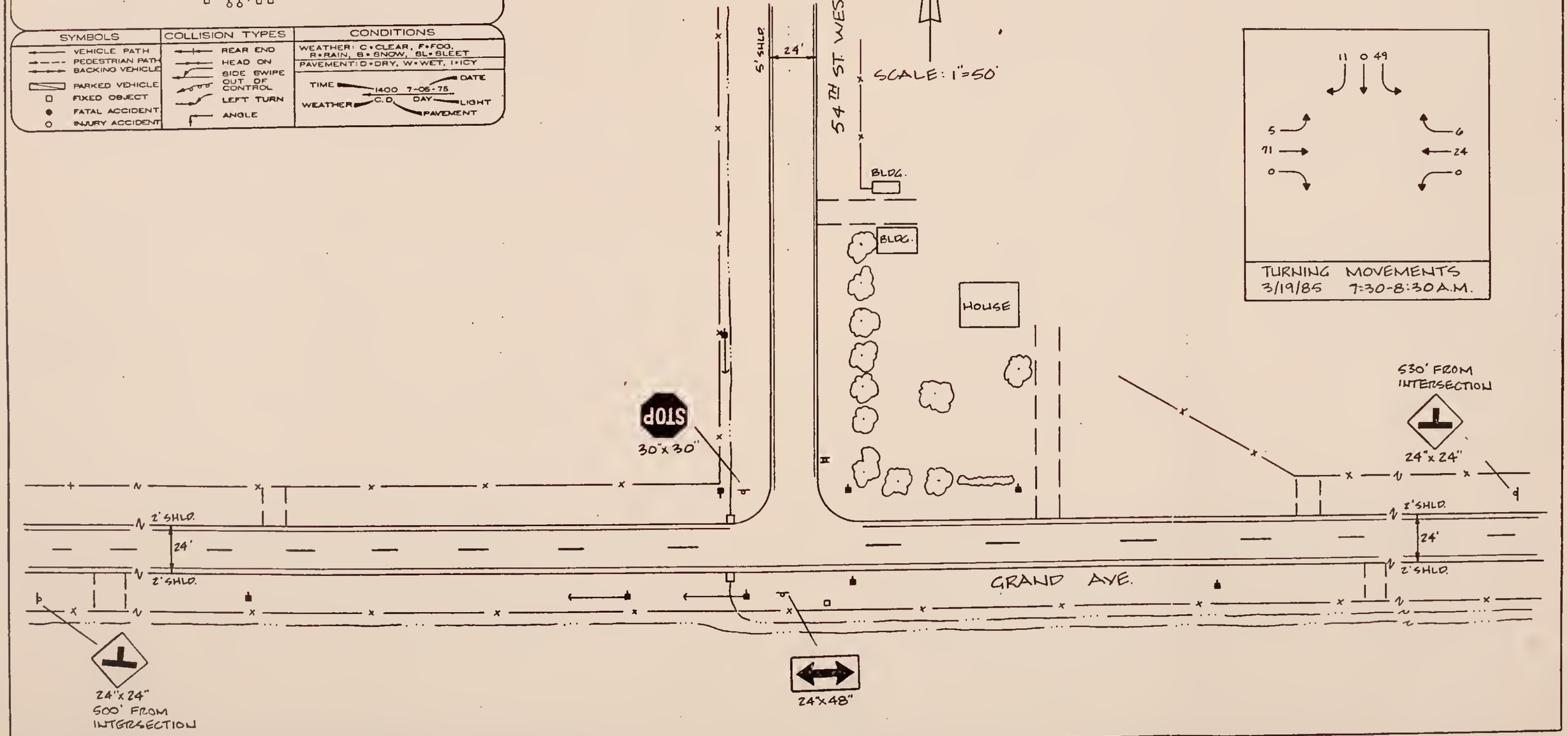
WEATHER CONDITIONS - % OF TOTAL :
- 9 CLEAR = 75%
- 2 RAIN = 17%
- 1 SNOW = 8%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 5 DRY = 42%
- 2 WET = 17%
- 5 ICY = 42%

LIGHT CONDITIONS - % OF TOTAL :
- 11 DARK = 92%
- 1 DAY = 8%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 1 INJURY = 8%
- 11 PROP DAM= 92%

ALCOHOL INVOLVED
5 % TOTAL = 42%



TURNING MOVEMENTS
3/19/85 7:30-8:30 A.M.

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS, MT 59107
Ph. (406) 248-5086

Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: GRAND AVE. & 54TH ST. W. EXISTING CONDITIONS

Surveyed By:
Designed By:
Drawn By:
Checked By:
Date

Revisions
No. Date
No. Date
No. Date
No. Date

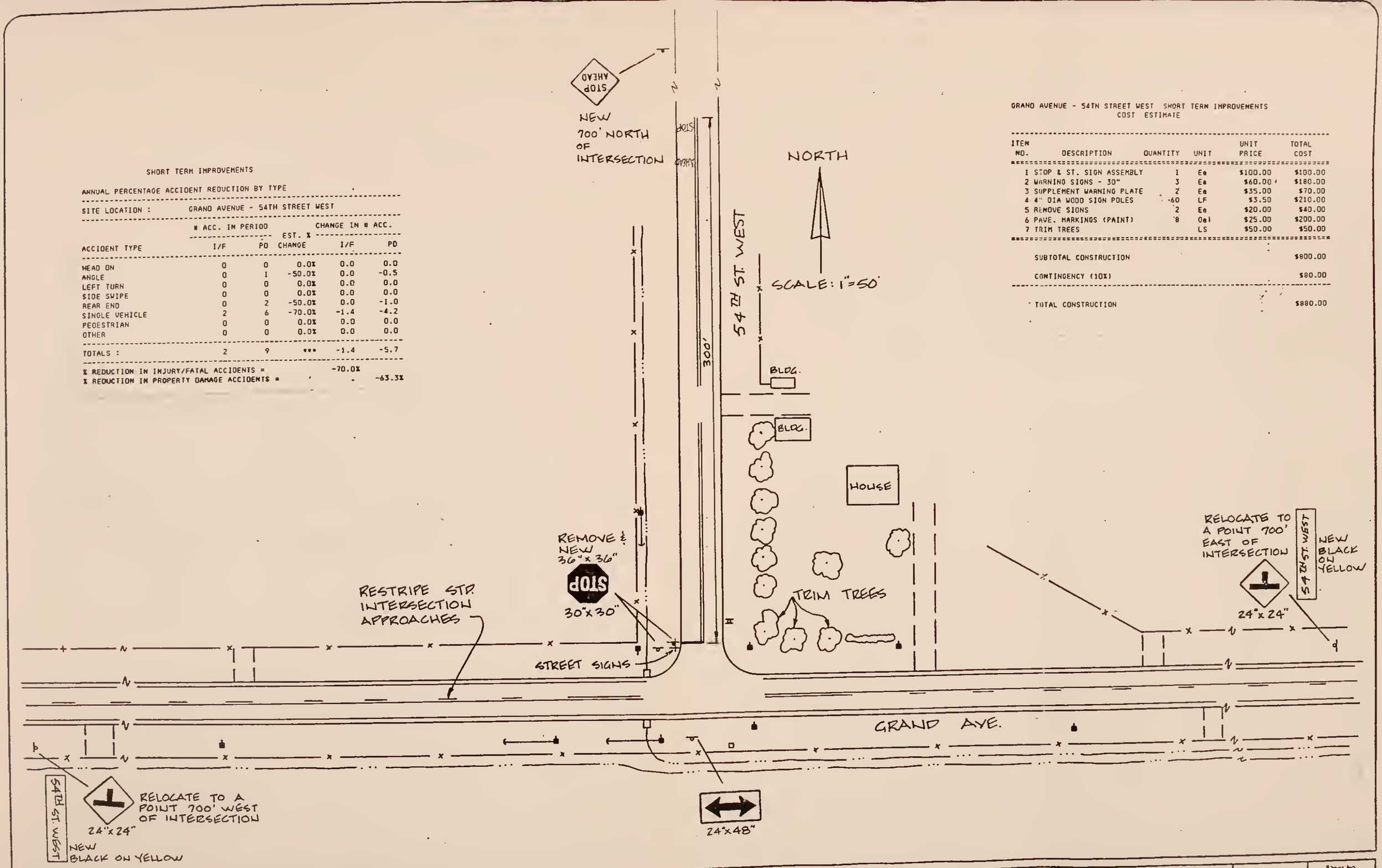
Project No.
Client No.
Sheet No.
of

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : GRAND AVENUE - 54TH STREET WEST

	# ACC. IN PERIOD			CHANGE IN # ACC.	
ACCIDENT TYPE	I/F	PD	EST. % CHANGE	I/F	PD
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	0	1	-50.0%	0.0	-0.5
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	0	0.0%	0.0	0.0
REAR END	0	2	-50.0%	0.0	-1.0
SINGLE VEHICLE	2	6	-70.0%	-1.4	-4.2
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	0	0	0.0%	0.0	0.0
TOTALS :	2	9	***	-1.4	-5.7
% REDUCTION IN INJURY/FATAL ACCIDENTS =				-70.0%	
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS =					-63.3%



GRAND AVENUE - 54TH STREET WEST SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	STOP & ST. SIGN ASSEMBLY	1	Ea	$100.00	$100.00
2	WARNING SIGNS - 30"	3	Ea	$60.00	$180.00
3	SUPPLEMENT WARNING PLATE	2	Ea	$35.00	$70.00
4	4" DIA WOOD SIGN POLES	60	LF	$3.50	$210.00
5	REMOVE SIGNS	2	Ea	$20.00	$40.00
6	PAVE. MARKINGS (PAINT)	8	Gal	$25.00	$200.00
7	TRIM TREES		LS	$50.00	$50.00
	SUBTOTAL CONSTRUCTION				$800.00
	CONTINGENCY (10%)				$80.00
	TOTAL CONSTRUCTION				$880.00

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS MT 59107
Ph. (406) 248-6066

Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: GRAND AVE. & 54TH ST. WEST SHORT TERM IMPROVEMENTS

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Checked By
Date

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No. Date
No. Date
No. Date

Project No.
Code No.

Sheet No.
of

SHEPHERD ROAD - CHICAGO ROAD INTERSECTION

PRIORITY NUMBER 2

SITE DESCRIPTION

Shepherd Road and Chicago Road are rural county roads near Shepherd, Montana. Shepherd Road is the major route and is on a north-south bearing. Chicago Road is a east-west road and is the minor road. The intersection is located approximately .25 miles north of the Highway 312 intersection with Shepherd Road and 2.5 miles south of Shepherd, Montana.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection is a typical 4 approach 90 degree intersection. The approach grades are all less than 1%. The most notably features of the roadway is the deep roadside ditches which drop off the shoulder at a 2:1 slope. With a 22+ foot width there is little room for deviation of vehicle paths.

Traffic Control Devices. Two sign types were found within the vicinity of the intersection. Stop signs and speed limit signs are both located on Chicago Road. No other signing pertaining to intersection operations were found.

he only visible pavement markings were found on Shepherd Road. That striping is not the standard intersection marking for no passing. It appears that there was a double solid yellow stripe on the east approach on Chicago Road but it is very hard to discern because of

wear.

Traffic Volumes. Total entering traffic at this intersection is very light but all turning movements were represented during the one hour counting period. ADT on Shepherd Road is approximately 1,500 and Chicago Road ADT is 300.

Traffic Operations. Since Chicago Road is an extended route in a rural setting with few intersecting roads, the stop condition is unexpected. The lack of any physical clues of the intersection's existence upon approaching contributes to the lack of expectancy. Observations indicated that deceleration rates on the Chicago Road approaches are probably greater than normal. Accompanying photos show evidence of this situation by way of skid marks on the pavement.

A similar condition exists on Shepherd Road in that the intersection area is not apparent upon approach and entering or turning vehicles cause emergency braking. The steep inslopes on the drain ditches and narrow pavement leave no room for avoidance maneuvering.

Accidents. Four of the 11 accidents in the four year reporting period were angle accidents. The observed expectancy problems were directly related to these accidents and at least 50% of the other accidents which were off road accidents. The high speed operation and harsh roadside geometrics contributed to the relatively high degree of severity.

SHORT TERM IMPROVEMENTS

Improved motorist information is clearly required to improve driver expectancy. The short term improvement sketch details the recommended signs and markings which conform to MUTCD requirements. Advanced warning on all approaches should provide the necessary information concerning intersection control. In addition to advanced warning, the stop signs on Chicago Road should be oversized (36x36) and positioned to maintain maximum visibility.

Pavement markings should conform to standard intersection markings. Proper markings provide a subtle clue that reinforces advanced warning signs. As with other intersection recommendations, the supplementary name plates should be mounted below the intersection warning sign to inform turning motorists of the advancing movement. The advanced warning is supplemented by the street name signs to be mounted above the stop signs.

The estimated cost of these improvements is estimated to be approximately $1,300 based on 1985 unit bid contract prices. The county may be able to effect the recommended improvements if completed with county maintenance forces and wholesale material costs. This site, like Grand & 54th has a high B/C ratio and should be implemented immediately.

Long term improvements at this intersection cannot be anticipated beyond the short term improvements unless unanticipated development significantly increases volumes on one or both roads. If future conditions require roadway improvements, top priority should be given to flattening the roadside ditches and widening the shoulder sections.

BENEFITS

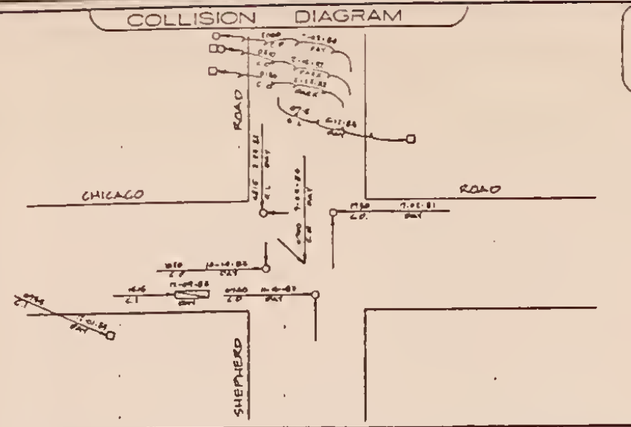
The greatest percentage accident reduction expected from the improvements would be for angle accidents. Since sight distance is apparently not a contributing factor, the advanced warning may provide a 70% reduction in those type of accidents. A more conservative reduction would be anticipated for other types of accidents.

The annual dollar benefit that may be realized is computed to be approximately $9,600. The benefit/cost ratio would therefore be in excess of 30.

FUNDING CONSIDERATIONS

The same funding source and timing is recommended for the improvements at this intersection as for the priority number 1 site.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 DATE 7-05-75
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT PAVEMENT
FIXED OBJECT	LEFT TURN	
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 1
- 1982= 4
- 1983= 4
- 1984= 2

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 4 ANGLE = 36%
- 0 LEFT TURN= 0%
- 1 SIDE SWP.= 9%
- 0 REAR END = 0%
- 1 SINGLE V = 9%
- 5 OTHER = 45%

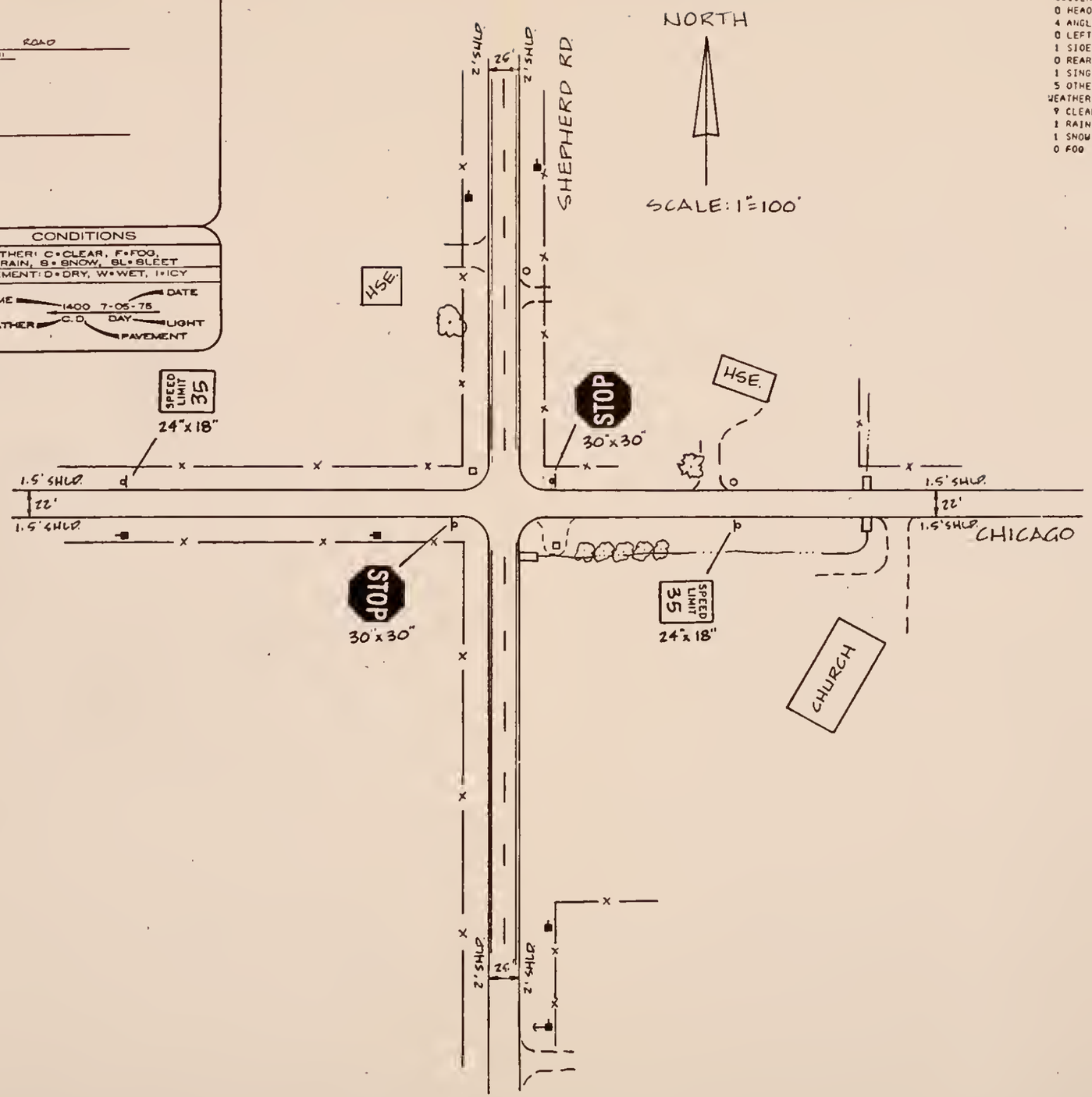
WEATHER CONDITIONS - % OF TOTAL :
- 9 CLEAR = 82%
- 1 RAIN = 9%
- 1 SNOW = 9%
- 0 FOG = 0%

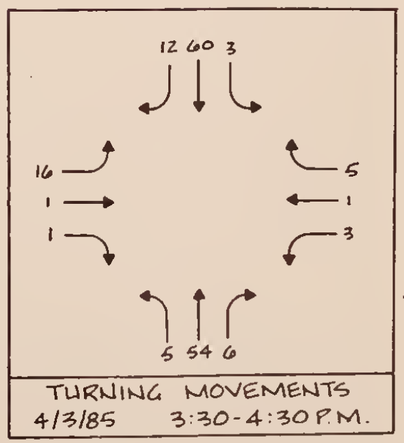
ROAD CONDITIONS - % OF TOTAL :
- 7 DRY = 64%
- 0 WET = 0%
- 4 ICY = 36%

LIGHT CONDITIONS - % OF TOTAL :
- 2 DARK = 18%
- 9 DAY = 82%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 6 INJURY = 55%
- 5 PROP DAM= 45%

ALCOHOL INVOLVED
2 % TOTAL = 18%





TURNING MOVEMENTS
4/3/85 3:30-4:30 P.M.

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN II
404 N. 31st
BILLINGS, MT 59107
Ph. (406) 248-6088

Project: TRAFFIC SAFETY STUDY — YELLOWSTONE COUNTY ROADS

Sheet Title: SHEPHERD RD. & CHICAGO RD. EXISTING CONDITIONS

Surveyed By:
Designed By:
Drawn By:
Checked By:
Date:

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Client No.
Sheet No.
of

SHORT TERM IMPROVEMENTS

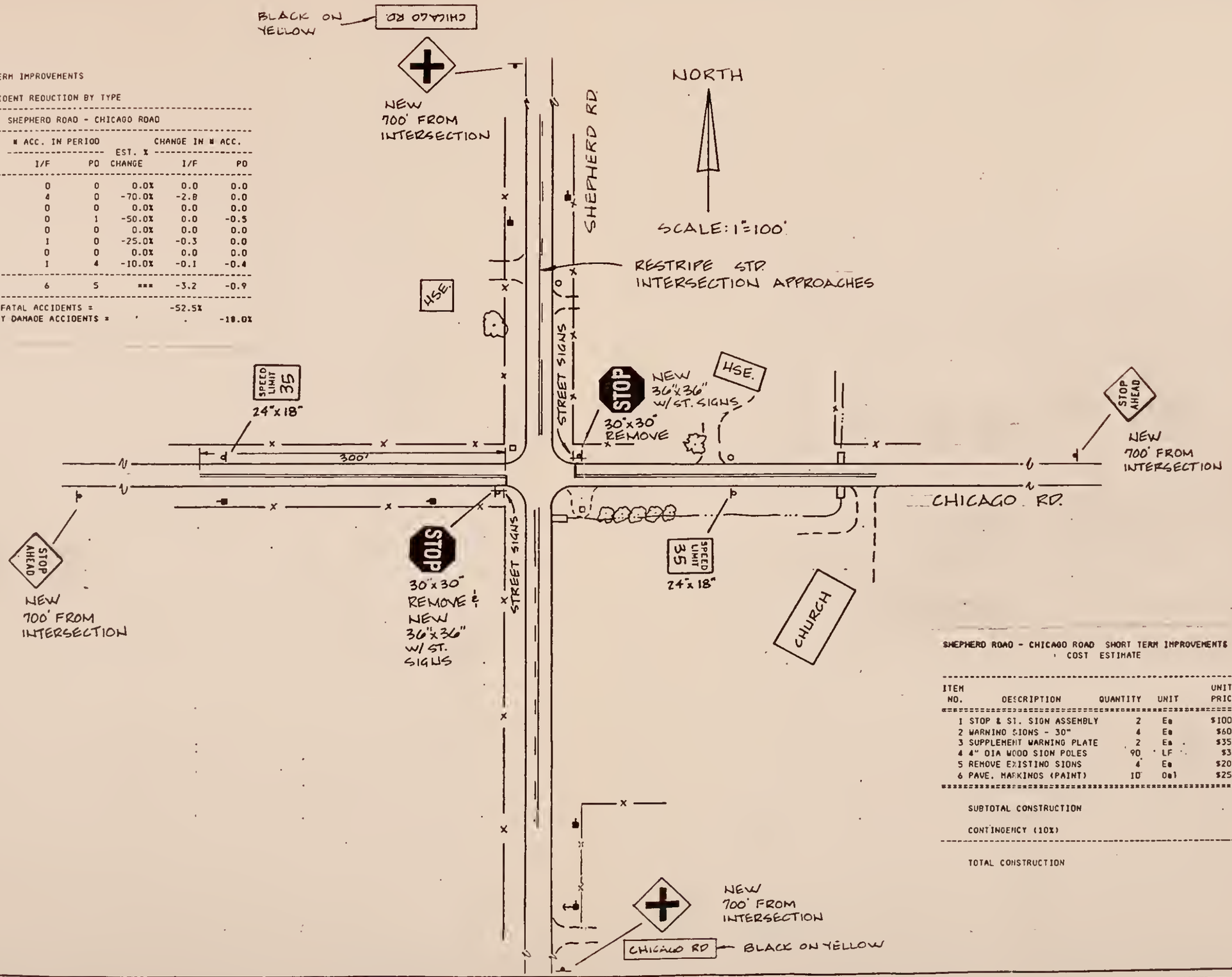
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : SHEPHERD ROAD - CHICAGO ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	4	0	-70.0%	-2.8	0.0
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	1	-50.0%	0.0	-0.5
REAR END	0	0	0.0%	0.0	0.0
SINGLE VEHICLE	1	0	-25.0%	-0.3	0.0
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	1	4	-10.0%	-0.1	-0.4
TOTALS :	6	5	===	-3.2	-0.9

% REDUCTION IN INJURY/FATAL ACCIDENTS = -52.5%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -18.0%



SHEPHERD ROAD - CHICAGO ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	STOP & ST. SIGN ASSEMBLY	2	Ea	$100.00	$200.00
2	WARNING SIGNS - 30"	4	Ea	$60.00	$240.00
3	SUPPLEMENT WARNING PLATE	2	Ea	$35.00	$70.00
4	4" DIA WOOD SIGN POLES	90	LF	$3.50	$315.00
5	REMOVE EXISTING SIGNS	4	Ea	$20.00	$80.00
6	PAVE. MARKINGS (PAINT)	10	Del	$25.00	$250.00
	SUBTOTAL CONSTRUCTION				$1,155.00
	CONTINGENCY (10%)				$115.50
	TOTAL CONSTRUCTION				$1,270.50

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N 31st
BILLINGS MT 59101
Ph. (406) 248-6088

Project: TRAFFIC SAFETY STUDY — YELLOWSTONE COUNTY ROADS

Sheet Title: SHEPHERD RD. & CHICAGO RD. SHORT TERM IMPROVEMENTS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No
Count No

Sheet No.
of

#3

HIGHWAY 10 E - GOLF COURSE ROAD INTERSECTION

PRIORITY NUMBER 3

SITE DESCRIPTION

Highway 10E is a former U.S. Highway Route that was replaced when Interstate 90 was constructed nearly 20 years ago. It currently serves as a north frontage road to the interstate. It is segmented by the interstate highway but it has continuity from a point 3 miles east of Laurel to Park City (7 miles west of Laurel). It only serves as a collector for local rural access at present.

Golf Course Road, as its name implies, serves as an access road for the Laurel Country Club. In addition, a few residential dwelling are also served by Golf Course Road. It extends north of Highway 10E approximately 0.5 miles.

EXISTING CONDITIONS

Geometrics. The existing condition sketch shows a 4 approach intersection with two legs being offset. The south leg of this intersection is actually a dead end road which accesses a farm. That access is a gravel surfaced roadway and should be considered a private access.

The approach grades on all of the three paved main approaches are approximately 1% and the private access road is approximately 3%. Roadside ditches have at least 2:1 side slopes and are most severe at the intersection radii where irrigation and short drainage pipes create nearly vertical drop offs.

Other roadside hazards are not prevalent along either of the

roadways except at the intersection area. There, power poles and trees are in direct line of errant vehicles.

Traffic Control Devices. At some time in the past an attempt was made at providing informational and warning signs. Two guide signs indicating the direction of Golf Course Road were installed on Highway 10E, however they are too far away from the intersection. An oversized stop sign was installed on Golf Course Road but it is not reinforced by advanced warning signs. The double arrow sign is present but it is not located within direct line of approaching traffic and therefore does not provide the necessary information. A dead end sign erected on the private access is located such that it dominates the attention of south bound approach traffic and distracts from the important information provided by the stop and double arrow signs, especially at night.

Striping on both roadways is well worn. The fog lines on Golf Course Road are nearly obliterated.

Traffic Volumes. Total entering traffic at this intersection is very light. A one hour counting period provided sufficient information to factor an ADT of 1,300 on Highway 10E and 300 on Golf Course Road. Peak approach traffic volumes on Golf Course Road probably do not occur until the time period after sunset because of the nature of its access requirements. This is also the period of time that the majority of the accidents have occurred.

Traffic Operations. Since Golf Course Road is characterized by short peaks of traffic at unpredictable periods during the day very little opportunity to observe driver behavior was available. From a drivers viewpoint, the lack of physical evidence and advanced warning contributes to an overall lack of expectancy. In the case of the misplaced double arrow sign, the information that is provided is misleading. Considering that a power pole is in direct line with the southbound approach, that bit of information has the potential for serious consequences.

Accidents. Three of the six accidents in the four year reporting period could be associated with the intersection geometrics and violation of expectancy. Since all but one of the accidents were at night, lighting and driver reaction also were major contributing factors. The other accidents were either off road accidents or fixed object accidents that may or may not involve the presence of the intersection. Higher speed vehicle operation contributed to the relatively high degree of accident severity at this intersection.

SHORT TERM IMPROVEMENTS

Improved motorist information is clearly required to improve driver expectancy. The short term improvement sketch details the recommended signs and markings which conform to MUTCD requirements. Advanced warning on all approaches should provide the necessary information concerning intersection control. In addition to advanced warning, the double arrow sign and dead end warning signs should be located to provide maximum visibility without causing confusion or

conflicting information.

Pavement markings should be repainted and should conform to standard intersection markings. Continued maintenance of striping is necessary to insure that they reinforce the advanced warning signs. This is especially important since Golf Course Road is used predominantly during the clear whether periods when pavement markings have their maximum benefit.

As with other intersection recommendations, the supplementary name plates should be mounted below the intersection warning sign to inform turning motorists of the advancing movement. The advanced warning will be supplemented by the directional guide signs which should be located nearer the intersection.

The estimated cost of these improvements is estimated to be approximately $1,900 based on 1985 unit bid contract prices. The county may be able to effect the recommended improvements if completed with county maintenance forces and wholesale material costs. This site, like the first two priority sites, has a high B/C ratio and should be implemented immediately.

Long term improvements at this intersection cannot be anticipated beyond the short term improvements unless unanticipated development significantly increases volumes on one or both roads. If future conditions require roadway improvements, top priority should be given to flattening the roadside ditches and widening the shoulder sections.

BENEFITS

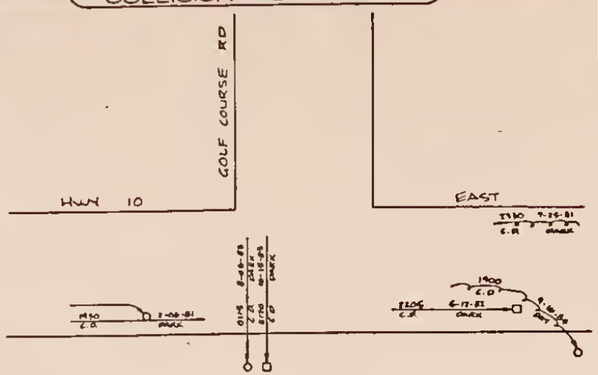
The greatest percentage accident reduction expected from the improvements would be for the southbound off road accidents. Since sight distance is apparently not a contributing factor, the advanced warning may provide a 70% reduction in those type of accidents. A more conservative reduction would be anticipated for other types of accidents.

The annual dollar benefit that may be realized is computed to be approximately $10,100. The benefit/cost ratio would therefore be in excess of 10.

FUNDING CONSIDERATIONS

The same funding source and timing is recommended for the improvements at this intersection as for priority number 1 and 2 sites.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-06-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 2
- 1982= 1
- 1983= 2
- 1984= 1

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 0 ANGLE = 0%
- 0 LEFT TURN= 0%
- 1 SIDE SWP.= 17%
- 0 REAR END = 0%
- 3 SINGLE V = 50%
- 2 OTHER = 33%

WEATHER CONDITIONS - % OF TOTAL :
- 6 CLEAR = 100%
- 0 RAIN = 0%
- 0 SNOW = 0%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 6 DRY = 100%
- 0 WET = 0%
- 0 ICY = 0%

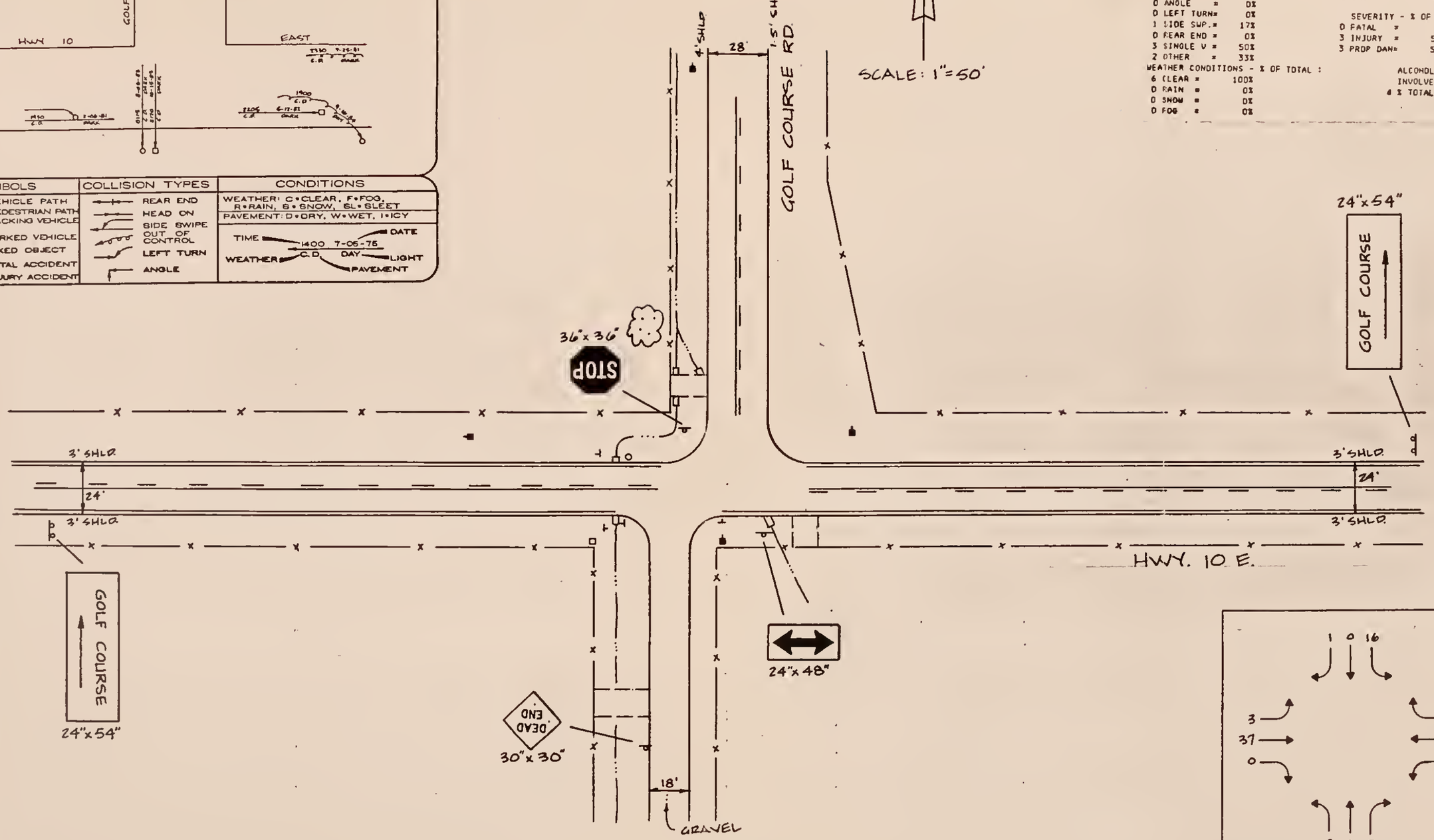
LIGHT CONDITIONS - % OF TOTAL :
- 5 DARK = 83%
- 1 DAY = 17%

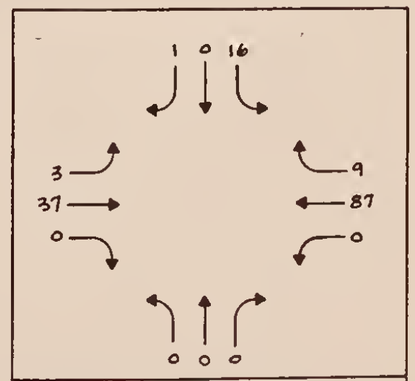
SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 3 INJURY = 50%
- 3 PROP DAM= 50%

ALCOHOL INVOLVED
4 % TOTAL = 67%

NORTH

SCALE: 1"=50'





TURNING MOVEMENTS
4/1/85 4:00-5:00 P.M.

MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers	SUITE 304 TRANSWESTERN I 404 N. 31st BILLINGS, MT 59107 Ph (406) 248-8088	Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS	Sheet Title: HWY. 10 E. & GOLF COURSE RD. EXISTING CONDITIONS	Surveyed By: Designed By: Drawn By: Checked By: Date:	Revisions No. Date No. Date No. Date No. Date Project No. Client No Sheet No. of

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 10 EAST - GOLF COURSE ROAD

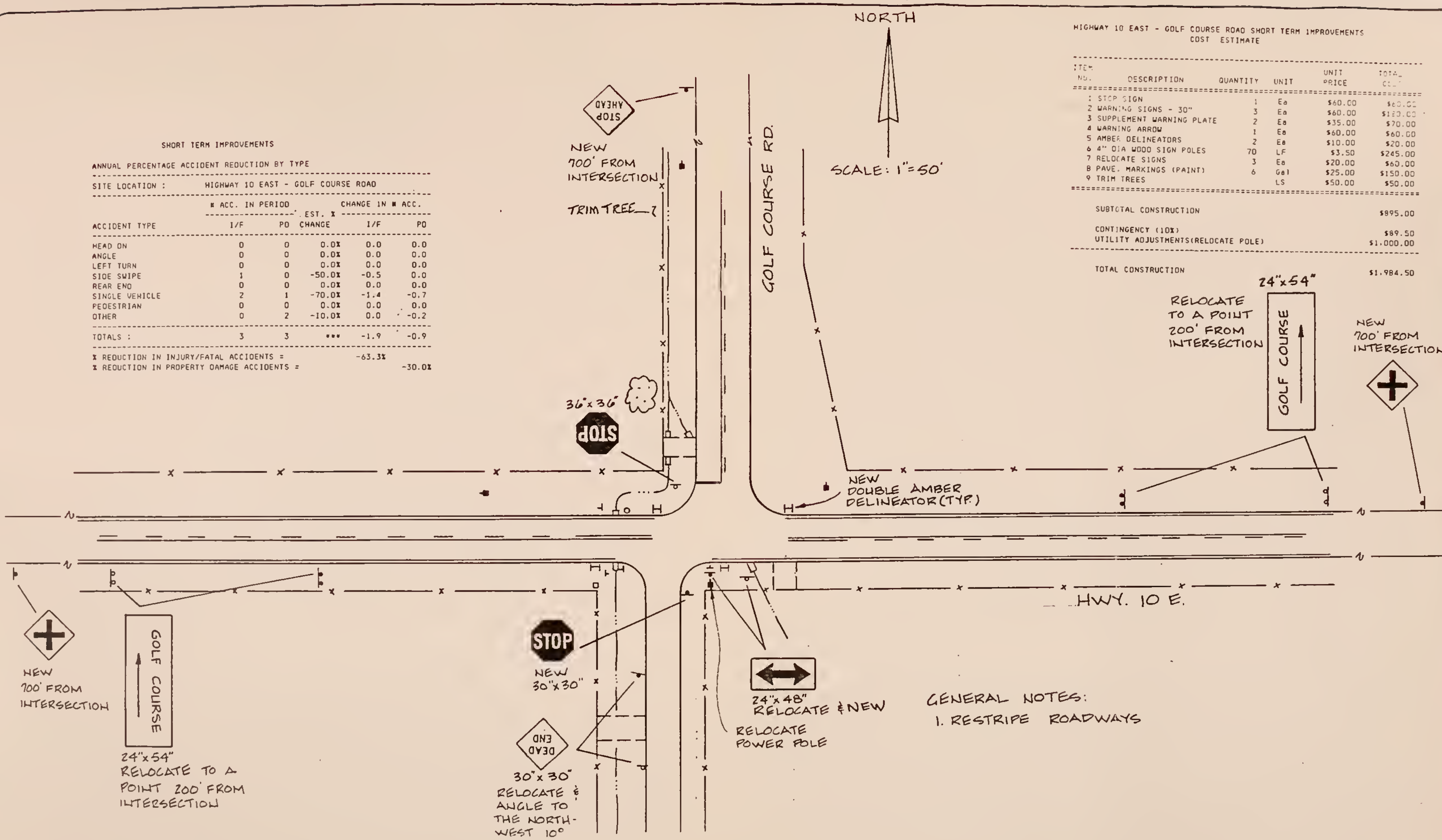
ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PO	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PO
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	0	0	0.0%	0.0	0.0
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	1	0	-50.0%	-0.5	0.0
REAR END	0	0	0.0%	0.0	0.0
SINGLE VEHICLE	2	1	-70.0%	-1.4	-0.7
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	0	2	-10.0%	0.0	-0.2
TOTALS :	3	3	***	-1.9	-0.9

% REDUCTION IN INJURY/FATAL ACCIDENTS = -63.3%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -30.0%

HIGHWAY 10 EAST - GOLF COURSE ROAD SHORT TERM IMPROVEMENTS COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	STOP SIGN	1	Ea	$60.00	$60.00
2	WARNING SIGNS - 30"	3	Ea	$60.00	$180.00
3	SUPPLEMENT WARNING PLATE	2	Ea	$35.00	$70.00
4	WARNING ARROW	1	Ea	$60.00	$60.00
5	AMBER DELINEATORS	2	Ea	$10.00	$20.00
6	4" DIA WOOD SIGN POLES	70	LF	$3.50	$245.00
7	RELOCATE SIGNS	3	Ea	$20.00	$60.00
8	PAVE. MARKINGS (PAINT)	6	Gal	$25.00	$150.00
9	TRIM TREES		LS	$50.00	$50.00
	SUBTOTAL CONSTRUCTION				$895.00
	CONTINGENCY (10%)				$89.50
	UTILITY ADJUSTMENTS(RELOCATE POLE)				$1,000.00
	TOTAL CONSTRUCTION				$1,984.50



GENERAL NOTES:

1. RESTRIPE ROADWAYS

MARVIN & ASSOCIATES
TRANSWESTERN
404 N 31st
BILLINGS MT
Traffic Transportation & Civil Engineers
Ph (406) 248-5085

Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: HWY 10 E. & GOLF COURSE RD. SHORT TERM IMPROVEMENTS

#4

OLD HARDIN ROAD - BECRAFT LANE INTERSECTION

PRIORITY NUMBER 4

SITE DESCRIPTION

Old Hardin Road is a minor arterial which extends from the Lockwood I-90 Interchange at its western terminus to a point near the Pinehills I-90 Interchange at its eastern terminus. It serves as a northern frontage road to I-90 and provides access to the major portion of the urban area known as Lockwood.

Becraft Lane is classified as a collector street and it is a major access street to recently constructed residential subdivisions southeast of Old Hardin Road. From its intersection with Old Hardin Road it continues on an east bearing approximately 1 mile and terminates at Noblewood Drive.

The intersection is located approximately 2 miles northeast of the Lockwood interchange. Johnson Lane, which is has a direct bearing in the operation of the intersection, is located 350 feet south west of Becraft Lane. Johnson Lane is currently classified as a major arterial and will have future access to I-90 when a planned interchange 800 feet north of the site is constructed (approximately 1987).

EXISTING CONDITIONS

Geometrics. Both the Becraft and Johnson Lane intersections with Old Hardin Road are shown in the existing condition sketch.The Johnson Lane intersection is skewed approximately 30 degrees from a right angle and has a large area of paving to accommodate turning

movements. Becraft Lane intersects Old Hardin Road at nearly 90 degrees. The alignment of Becraft preceding the intersection is curved sharply to provide the right angle intersection. All approach grades are within the range between 1% and 2%.

The only significant roadside development at this site is a convenience store which is situated between Johnson Lane and Becraft Lane on the south side of the road. The approaches to this store are from Old Hardin Road. It appears that some attempt was made to control access since extensive site grading to separate the approaches was completed and guardrail was installed. The majority of similar site developments along Old Hardin Road exist without any access control features.

Other features of the roadside include vegetation, power poles, irrigation ditches and advertising signs. Roadside ditches are shallow except in the area of the intersection where site grading has occurred. The inslopes in that area are approximately 2:1.

The Montana Department of Highways does not currently have plans to modify the intersection geometrics at this site when the I-90 interchange is constructed. Any redirection of traffic caused by the interchange would therefore utilize the existing intersection geometrics.

Traffic Control Devices. Standard speed signs and stop signs provide the regulatory information at this location. The only warning devices are arrow signs at the outside edge of the Becraft curve and at the end of the T intersection.

Hazard markers do exist at the ends of the guardrail sections.

This situation is in itself is a paradox since the guardrail was probably installed as a safety device and then signed as a hazard. Not only is the guardrail unwarranted, it is extremely close to the traveled lanes which narrows the effective lane widths, provides no avoidance area and ensures that damage will be done to any errant vehicle.

The only pavement markings that are not worn beyond recognition are the dashed yellow centerlines on Old Hardin Road. It doesn't appear that standard intersection markings were ever striped.

Traffic Volumes. Traffic volumes at this intersection are heavy considering the rural type surroundings. The ADT on Old Hardin Road west of Becraft is approximately 4,800 while it is 2,800 east of the intersection. Becraft Lane has an ADT of 2,100. ADT on Johnson Lane is less than half of that on Becraft.

The existing condition sketch shows turning movement volumes taken during the peak evening hour. The heavy intersection turning movement volumes are further complicated by the existence of the convenience store approaches. The store's approach traffic represents 15% of the total traffic on Old Hardin Road during the peak evening hour.

Traffic Operations. Serious conflict movements occur within the intersection complex due to the closeness of the two intersections, the lack of traffic control features appropriate to the situation and the existence of a major traffic generator between the two intersections. Some of the conflict movements observed were:

1. Vehicles making passing maneuvers on Old Hardin Road just prior to and within the intersection areas.

2. Vehicles exiting the convenience store lot from the western approach proceeding to the south on Johnson Lane have a sharp angle of traverse through the intersection area and must drive on the wrong side of the road for a short distance.

3. Several turning movements from Old Hardin Road cause confusion to motorists stopped at the store approaches and the road approaches in anticipation of entering Old Hardin Road. The normal distance for turn signal indications overlap into the following approach and the waiting motorist assumes the approaching vehicle is turning prior to his location. In addition, waiting vehicles block each others line of sight. At least 12 combinations of vehicle positions can occur which cause this situation. Considering the volume of traffic involved, this situation occurs almost constantly.

4. At night, the area lighting and advertising sign for the store is so bright that extreme glare causes the driver to loose visibility of the roadway features.

5. The sharp curve and abundant vegetation on Becraft Lane disguises the approach conditions at Old Hardin Road and anticipation of the stop is not sufficient even to drivers familiar with the road.

Accidents. The collision diagram and accident statistics table shown on the existing condition sketch indicate that almost all of the accidents could be related to the above detailed operational problems. One other condition that was highly evident when accident reports were

reviewed was the high accident occurrence on icy roads (56% of 18 total accidents). Given the relatively high traffic volumes, turning movements and stops, winter maintenance efforts at this location are probably not as intense as they should be.

Severity of accidents at this intersection is not high probably because increasing traffic volumes have caused a reduction in vehicle speeds. The existing speed limit seems to be appropriate for the prevailing speeds and conditions.

SHORT TERM IMPROVEMENTS

Very little can be done about the convenience store location at this point in time. The operational deficiencies which relate to the store could be improved somewhat if the two Old Hardin Road approaches were consolidated at a point midway between the intersections. It is recommended that this action be considered if the county has a mechanism to effect changes on existing businesses. If not, the approach situation should be improved when long term improvements are made to Old Hardin Road.

The short term improvement sketch contains a combination of improvements that would accomplish the following:

1. Remove roadside obstacles which inhibit avoidance maneuvers and create potential for severe accidents.

2. Delineate the roadway and operational requirements of the intersections by striping and markers.

3. Provide advanced warning and informational signing to raise the level of expectancy.

4. Increase winter maintenance intensity to accommodate the

unique operational requirements of this site.

The cost of these improvements is estimated to be approximately $9,900 based on 1985 unit bid contract prices. It is recommended that the improvements, especially the earthwork, be engineered and plans be developed to insure proper geometric controls.

The cost of improved maintenance at this site was added into the annual cost of improvements for calculation of the benefit/cost ratio.

LONG TERM IMPROVEMENTS

Long term improvements should be anticipated because the new interchange will undoubtedly create changes in land use within the area with commensurate changes in future operation requirements. Even at current volume levels, a dramatic redirection of traffic will occur when the interchange is complete and provisions for traffic control must be considered.

While definitive data regarding traffic movements is not available, it seems likely that auxiliary turn lanes will be required on Old Hardin Road. This would mean widening of the roadway surface along with installation of additional traffic control devices. These improvements should be considered as either a part of the interchange project or should be funded by the developments as they are planned and constructed.

BENEFITS

The greatest percentage accident reduction resulting from short term improvements would be predicted for angle accidents and rear end accidents. Also, sideswipe accidents would experience a significant

improvement. The basis for anticipated reductions is due mainly to improved advanced warning, delineation and provisions for avoidance maneuvers.

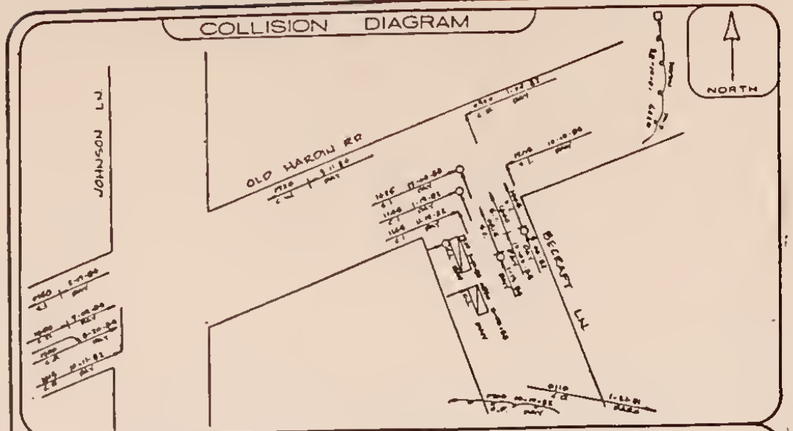
The annual dollar benefit that may be realized is computed to be approximately $17,300. The benefit/cost ratio would therefore be close to 5, which is relatively high for a project involving reconstruction.

FUNDING CONSIDERATIONS

Short term improvements can be funded by established county budget sources, establishment of a special program or by submitting this project into the Department of Highways Off System Safety program for prioritization.

Long term improvements, which may be necessary before funding of the short term improvements materialize, should either be included in the interchange project with the county making a cash contribution or land developments in the area which would contribute to traffic impact at this site should be assessed for improvements. The basis of assessment should be on the percentage of traffic generation from each development to the total. It may be necessary to master plan the area surrounding the interchange in order to determine the exact impacts and proportionate fiscal responsibility.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 DATE 7-05-75
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 1
- 1982= 7
- 1983= 5
- 1984= 5

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 6 ANGLE = 33%
- 0 LEFT TURN= 0%
- 1 SIDE SWP.= 6%
- 6 REAR END = 33%
- 2 SINGLE V = 11%
- 3 OTHER = 17%

WEATHER CONDITIONS - % OF TOTAL :
- 13 CLEAR = 72%
- 0 RAIN = 0%
- 5 SNOW = 28%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 6 DRY = 33%
- 2 WET = 11%
- 10 ICY = 56%

LIGHT CONDITIONS - % OF TOTAL :
- 2 DARK = 11%
- 16 DAY = 89%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 5 INJURY = 28%
- 13 PROP DAM= 72%

ALCOHOL INVOLVED
- 4 % TOTAL = 22%

TURNING MOVEMENTS
4/30/85 4:00-5:00 P.M.

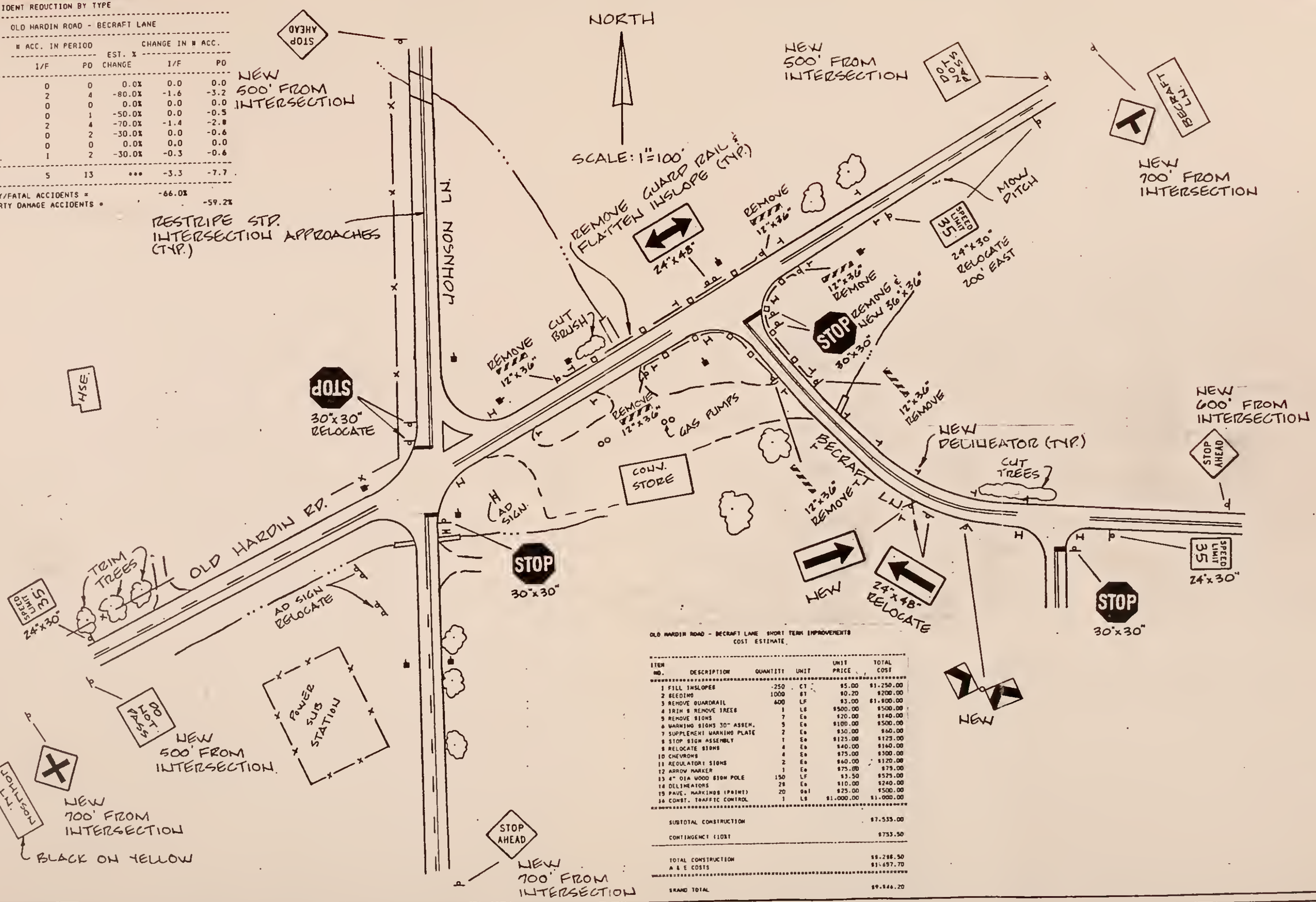
MARVIN & ASSOCIATES Traffic Transportation & Civil Engineers	SUITE 304 TRANSWESTERN II 404 N. 31st BILLINGS MT 59107 Ph. (406) 248-5068	Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS	Sheet Title: OLD HARDIN RD. & BECRAFT LN. EXISTING CONDITIONS	Surveyed By Designed By Drawn By Checked By Date Revisions No. Date Project No. Count No. Sheet No. of

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : OLD HARDIN ROAD - BECRAFT LANE

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	2	4	-80.0%	-1.6	-3.2
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	1	-50.0%	0.0	-0.5
REAR END	2	4	-70.0%	-1.4	-2.8
SINGLE VEHICLE	0	2	-30.0%	0.0	-0.6
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	1	2	-30.0%	-0.3	-0.6
TOTALS :	5	13	***	-3.3	-7.7

% REDUCTION IN INJURY/FATAL ACCIDENTS = -66.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -59.2%



OLD HARDIN ROAD - BECRAFT LANE SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	FILL INSLOPES	250	CY	$5.00	$1,250.00
2	SEEDING	1000	SY	$0.20	$200.00
3	REMOVE GUARDRAIL	600	LF	$3.00	$1,800.00
4	TRIM & REMOVE TREES	1	LS	$500.00	$500.00
5	REMOVE SIGNS	7	Ea	$20.00	$140.00
6	WARNING SIGNS 30" ASSEM.	5	Ea	$100.00	$500.00
7	SUPPLEMENT WARNING PLATE	2	Ea	$30.00	$60.00
8	STOP SIGN ASSEMBLY	1	Ea	$125.00	$125.00
9	RELOCATE SIGNS	4	Ea	$40.00	$160.00
10	CHEVRONS	4	Ea	$75.00	$300.00
11	REGULATORY SIGNS	2	Ea	$60.00	$120.00
12	ARROW MARKER	1	Ea	$75.00	$75.00
13	4" DIA WOOD SIGN POLE	150	LF	$3.50	$525.00
14	DELINEATORS	28	Ea	$10.00	$240.00
15	PAVE. MARKINGS (POINT)	20	Gal	$25.00	$500.00
16	CONST. TRAFFIC CONTROL	1	LS	$1,000.00	$1,000.00
	SUBTOTAL CONSTRUCTION				$7,535.00
	CONTINGENCY (10%)				$753.50
	TOTAL CONSTRUCTION				$8,288.50
	A & E COSTS				$1,657.70
	GRAND TOTAL				$9,946.20

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N 31st
BILLINGS MT 59107
Ph. (406) 248-5088

Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: OLD HARDIN RD. & BECRAFT LN. SHORT TERM IMPROVEMENTS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Case No.
Sheet No.
of

5

12 MILE ROAD - HOMER DAVIS ROAD INTERSECTION

PRIORITY NUMBER 5

SITE DESCRIPTION

Twelve Mile Road and Homer Davis Road are rural county roads which intersect north of Highway 312 and southwest of Shepherd, Montana. Twelve Mile Road is the major route and is on a north-south bearing. Homer Davis Road is an east-west road and is the minor route.

The intersection is located approximately 2.0 miles north of an intersection with Highway 312 known as five corners and 2.0 miles west of Shepherd Road, a parallel north-south road.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection is a typical 4 approach 90 degree intersection. The approach grades are all less than 1%. As is the case with numerous Yellowstone County Roads, roadside ditches drop off the shoulder at 2:1 slopes. The west side of 12 Mile Road is not quite typical because a trailer park has numerous approaches onto the road and the site has been graded almost level with the road.

Traffic Control Devices. Three sign types were found within the vicinity of the intersection; stop signs, warning signs and speed limit signs. The warning signs and stop signs are on Homer Davis Road and the speed limit sign is on 12 Mile Road.

The speed limit is probably correct. Even though 12 Mile Road is

a rural route where speeds are higher, the number of approaches and roadside dwelling units provide conditions that warrant a reduced speed.

Both stop signs and warning signs at this location are not highly visible and as is the condition at most of the rural study sites, the warning signs are placed too close to the intersection.

The only visible pavement markings were found on 12 Mile Road. Those stripes (fog lines) were badly worn.

Traffic Volumes. Total entering traffic at this intersection is very light but most of the turning movements were represented during the one hour counting period. ADT on 12 Mile Road is approximately 400 and Homer Davis Road ADT is 150.

Traffic Operations. Both roads have continuity for several miles with intersections at section lines. Vehicles operate at highway speeds on most sections except where there are extreme grades or obvious hazards. The roadside approaches and relatively high density development causes drivers to slow slightly near the site. It also appears that the roadside activity may draw attention away from the intersection area and contribute to the accident problem.

There appears to be a minor amount of pedestrian activity from the nearby dwellings. The accompanying photos show two youngsters on bikes on Homer Davis Road. Very light traffic volumes make it inviting for children to use the entire roadway when walking or riding bikes.

The dwelling located in the northeast quadrant of the intersection is a farmstead and the owner uses the Homer Davis Road

right-of-way to park his farm vehicles and equipment. He also stacks hay in the corner of his property near the intersection. Both of these practices cause reduced sight distance and in the case of the equipment, a roadside hazard.

Accidents. Three of the Four accidents in the four year reporting period were angle accidents. Observed expectancy problems were directly related to these accidents and the remaining accident was indirectly the result of roadside activity.

SHORT TERM IMPROVEMENTS

Improved motorist information is required to improve driver expectancy. The short term improvement sketch details the recommended signs and markings which conform to MUTCD requirements. Advanced warning on all approaches should provide the necessary information concerning intersection control. In addition to advanced warning, the stop signs on Homer Davis Road should be oversized (36x36) and positioned to maintain maximum visibility.

Pavement markings should conform to standard intersection markings. Proper markings provide a subtle clue that reinforces advanced warning signs. As with other intersection recommendations, the supplementary name plates should be mounted below the intersection warning sign to inform turning motorists of the advancing movement. The advanced warning is supplemented by the street name signs to be mounted above the stop signs.

The estimated cost of these improvements is estimated to be approximately $1,300 based on 1985 unit bid contract prices. The

county may be able to effect the recommended improvements if completed with county maintenance forces and wholesale material costs. This site, has a high B/C ratio and should be implemented immediately.

Long term improvements at this intersection cannot be anticipated beyond the short term improvements unless unanticipated development significantly increases volumes on one or both roads.

BENEFITS

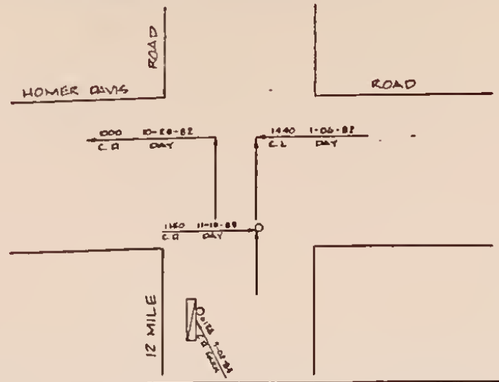
The greatest percentage accident reduction expected from the improvements would be for angle accidents. Since sight distance is only a minor contributing factor, the advanced warning may provide a 50% reduction in those type of accidents. A more conservative reduction would be anticipated for other types of accidents.

The annual dollar benefit that may be realized is computed to be approximately $4,160. The benefit/cost ratio would therefore be in excess of 7.

FUNDING CONSIDERATIONS

These improvements could possibly be completed with the counties annual road maintenance fund or be included in a special program.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C=CLEAR, F=FOG, R=RAIN, S=SNOW, SL=SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D=DRY, W=WET, I=ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 0
- 1982= 3
- 1983= 1
- 1984= 0

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 3 ANGLE = 75%
- 0 LEFT TURN= 0%
- 0 SIDE SWP.= 0%
- 0 REAR END = 0%
- 0 SINGLE V = 0%
- 1 OTHER = 25%

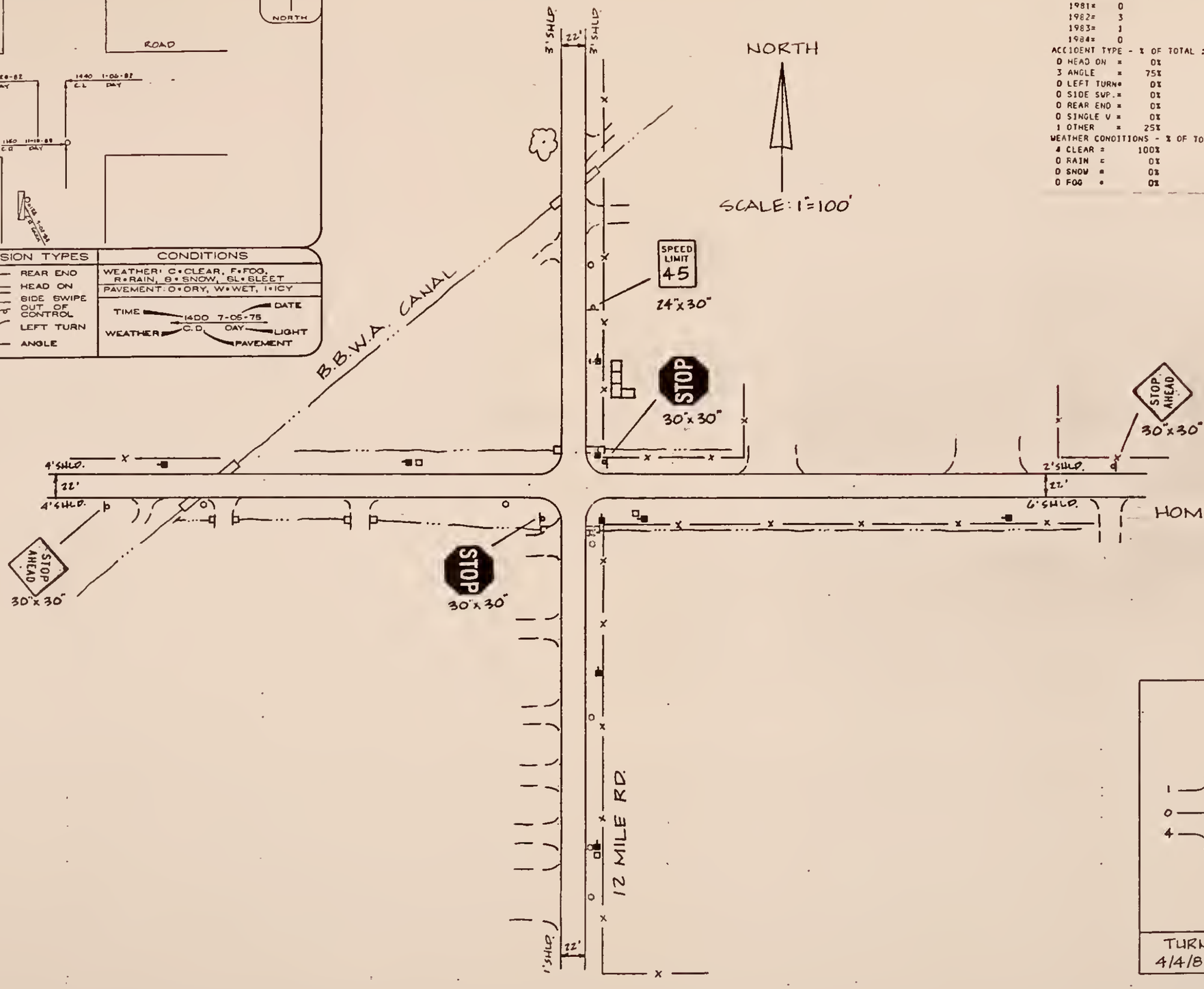
WEATHER CONDITIONS - % OF TOTAL :
- 4 CLEAR = 100%
- 0 RAIN = 0%
- 0 SNOW = 0%
- 0 FOG = 0%

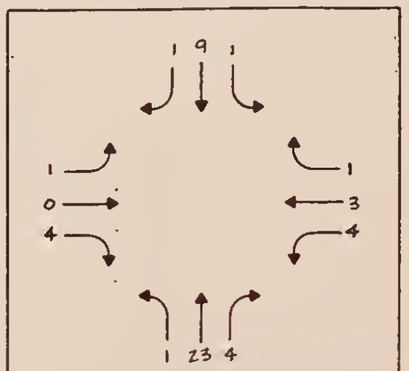
ROAD CONDITIONS - % OF TOTAL :
- 3 DRY = 75%
- 0 WET = 0%
- 1 ICY = 25%

LIGHT CONDITIONS - % OF TOTAL :
- 0 DARK = 0%
- 4 DAY = 100%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 2 INJURY = 50%
- 2 PROP DAM= 50%

ALCOHOL INVOLVED
0 % TOTAL = 0%





TURNING MOVEMENTS
4/4/85 4:00-5:00 P.M.

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N 31st
BILLINGS MT 59107
Ph (406) 248-5066

Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: 12 MILE RD. & HOMER DAVIS RD. EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Client No.
Sheet No.
of

SHORT TERM IMPROVEMENTS

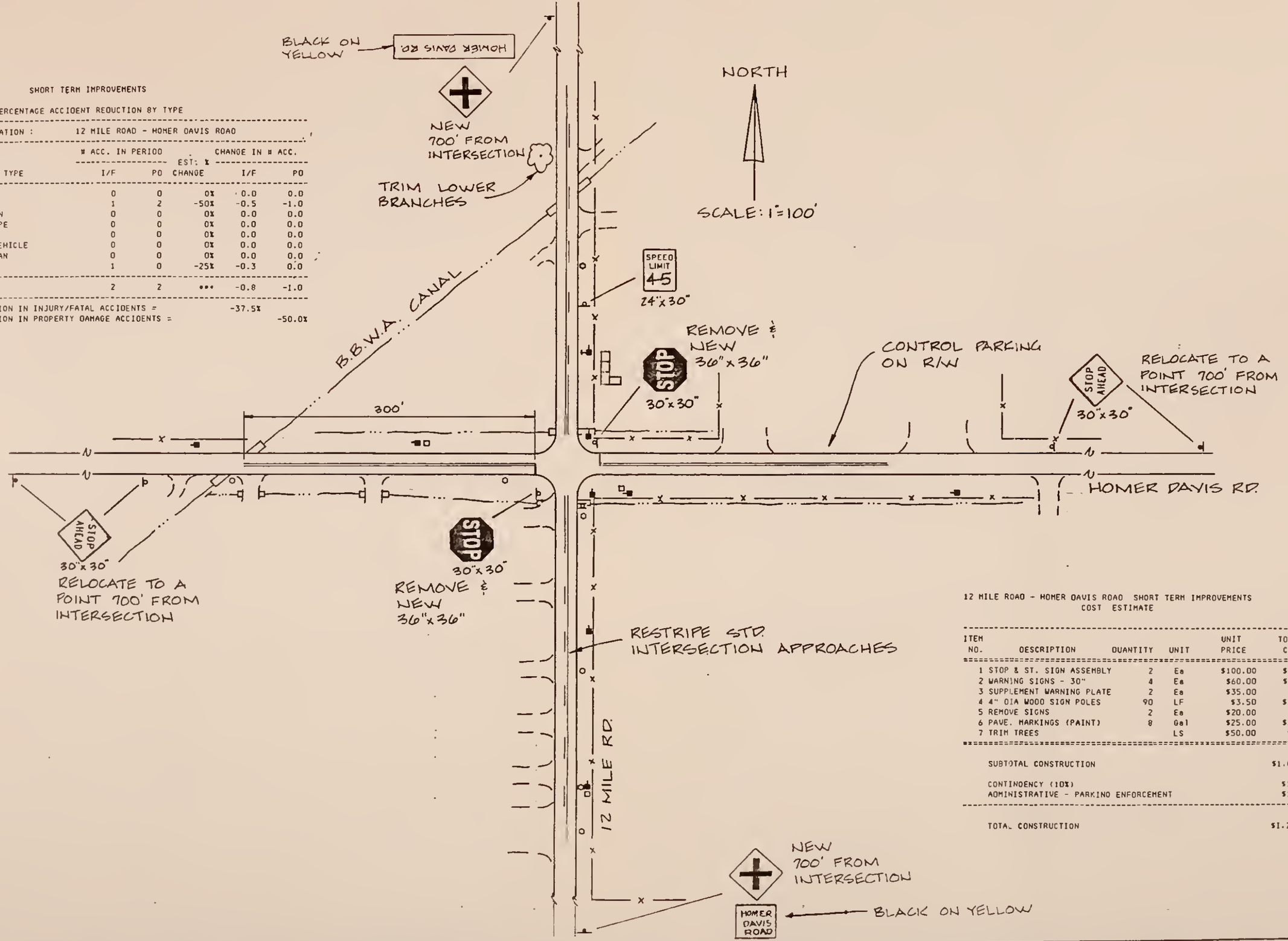
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : 12 MILE ROAD - HOMER DAVIS ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST: % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	1	2	-50%	-0.5	-1.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	0	0	0%	0.0	0.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	1	0	-25%	-0.3	0.0
TOTALS :	2	2	***	-0.8	-1.0

% REDUCTION IN INJURY/FATAL ACCIDENTS = -37.5%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -50.0%



12 MILE ROAD - HOMER DAVIS ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	STOP & ST. SIGN ASSEMBLY	2	Ea	$100.00	$200.00
2	WARNING SIGNS - 30"	4	Ea	$60.00	$240.00
3	SUPPLEMENT WARNING PLATE	2	Ea	$35.00	$70.00
4	4" DIA WOOD SIGN POLES	90	LF	$3.50	$315.00
5	REMOVE SIGNS	2	Ea	$20.00	$40.00
6	PAVE. MARKINGS (PAINT)	8	Gal	$25.00	$200.00
7	TRIM TREES		LS	$50.00	$50.00
	SUBTOTAL CONSTRUCTION				$1,065.00
	CONTINGENCY (10%)				$106.50
	ADMINISTRATIVE - PARKING ENFORCEMENT				$100.00
	TOTAL CONSTRUCTION				$1,271.50

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: 12 MILE RD & HOMER DAVIS RD SHORT TERM IMPROVEMENTS

*6

OLD HARDIN ROAD - PICCOLO LANE INTERSECTION

PRIORITY NUMBER 6

SITE DESCRIPTION

Old Hardin Road is a minor arterial which extends from the Lockwood I-90 Interchange at its western terminus to a point near the Pinehills I-90 Interchange at its eastern terminus. It serves as a northern frontage road to I-90 and provides access to the major portion of the urban area known as Lockwood.

Piccolo Lane is classified as a collector street. From its intersection with Old Hardin Road it continues north past an intersection with Old U.S. 87 to its northern terminus, approximately 1 mile. It serves residential areas north of Old Hardin Road.

The intersection is located approximately 1 mile northeast of the Lockwood interchange. The land adjacent to Old Hardin Road for a distance of approximately one mile on each side of the intersection is developed to a relatively high density.

EXISTING CONDITIONS

Geometrics. The intersection of Piccolo Lane and Old Hardin Road is shown in the existing condition sketch. Piccolo Lane is skewed approximately 30 degrees off of 90 degrees. A convenience type store located in the southwest quadrant of the intersection has its parking lot pavement abutting the roadways. Because there is no curb or other means of access control, there is a large area of paving with absolutely no guidance for vehicle movements.

Piccolo Lane is shown to have a 20 foot width. North of the

intersection area it narrows slightly. No discernable shoulders exist and irrigation and drainage ditches parallel the roadway along portions of its length.

Approach grades along both roads are flat (approximately 1 %). Numerous approaches along Old Hardin Road have filled in ditch sections and positive drainage control is lacking. It is assumed that large puddles appear in the intersection area after significant storms because of flat areas in the large area of paving.

Traffic Control Devices. Standard speed signs and stop signs provide the regulatory information at this location. The only warning devices are hazard markers at a irrigation crossing on Piccolo and a "stop ahead" sign mounted over a "dip" sign at the same location. It was not clear why the "dip" sign was installed since the dip in the road surface is hardly noticeable at prevailing speeds. Perhaps it is a derogatory statement directed toward the type of drivers who usually miss the stop sign.

There is a faint trace of a dashed yellow centerline on Old Hardin Road. No other markings or delineation were apparent in the intersection area.

Traffic Volumes. Traffic volumes at this intersection are high relative to the average site within this study. The ADT on Old Hardin Road west of Piccolo is approximately 7,300 while it is 6,800 east of the intersection. Piccolo Lane has an ADT of 1,500.

The existing condition sketch shows turning movement volumes taken during the peak evening hour. The heavy intersection turning

movement volumes are further complicated by the existence of uncontrolled access to the convenience store. The store's approach traffic represents 24% of the total traffic entering the intersection during the peak evening hour. With the number and type of access movements to the store, quite a bit of circulation within the intersection area occurs. If all of the movements that vehicles make accessing the store were counted the percentage of total traffic would be higher.

Traffic Operations. Serious conflict movements occur within the intersection area because of the uncontrolled access and the variety of turning movements.

Some of the conflict movements observed were:

1. Vehicles making passing maneuvers on Old Hardin Road just prior to and within the intersection area.

2. Vehicles enter and exit the parking lot area at all angles and speeds.

3. Vehicles parked against the convenience store along Piccolo Lane back out into the street and the maneuver area is so short that this movement is virtually blind.

4. Vehicles exiting the west end of the lot must pull out into the eastbound traffic lane to obtain a line of sight to the west.

5. Approximately 50% of all eastbound right turning traffic cuts through the lot either between the ad sign and the pumps or even worse, between the pumps and the building.

6. With such a wide paved area, vehicles often line up 2 or 3 abreast prior to executing their exit maneuvers.

7. There appears to be a moderate amount of pedestrian traffic along piccolo road. The width of that street provides little room for vehicles to pass and even less room to accommodate pedestrian or bike traffic.

8. Because of numerous roadside features and traffic conditions which occupy drivers attention, the intersection approach is unexpected, especially for eastbound traffic.

In addition to the above noted potential safety problems, the intersection's capacity is severely degraded because of unrestricted access. A situation exists where main roadway traffic is being delayed by private approach traffic.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicate very little correlation to the observed traffic operation problems. Only 25% of the accidents were angle accidents. A much higher incidence should be indicated considering the high volumes, uncontrolled access and extremely poor sight distance. Rear end accidents are predominant width 33% of the total. This statistic is also less than what could be expected under current conditions.

The most surprising trend is that accidents are consistently reducing with time. The only explanation that can be offered is that increasing volumes are beginning to congest the intersection to the point where drivers have become extremely cautious when approaching the intersection area. It is also possible that property damage accidents have been occurring but have not been reported either because they occurred in the lot or drivers don't want to risk an increase in insurance payments.

SHORT TERM IMPROVEMENTS

The major improvement that must be recommended is to control access from the convenience store. Considering the lack of curb and gutter sections within Lockwood, the only feasible method of physical separation between the lot and the street would be pin-down curb sections. The short term improvement sketch illustrates the use of these sections. Since this action would affect the parking layout for the store, implementation of these improvements would have to be discussed with the store owners.

Other improvements felt to be necessary involves advanced warning , positive guidance, regulatory parking controls, tree trimming and standard intersection pavement markings.

The cost of these improvements is estimated to be approximately $8,700 based on 1985 unit bid contract prices. It is recommended that the improvements be engineered and plans be developed to insure proper geometric controls.

The cost of improved maintenance at this site was added into the annual cost of improvements for calculation of the benefit/cost ratio.

LONG TERM IMPROVEMENTS

The long term improvements are highly dependant upon the level of traffic volumes that can be expected after the Johnson Lane Interchange is in operation and what type of land use is proposed for the now vacant southeast quadrant of the intersection. The one long term improvement that should be made is the widening of Piccolo Lane. At a minimum it should provide 2-12 foot traffic lanes an 8 foot shoulders, with physical separation, on one or the other side for

pedestrians or bikes. Near the intersection Piccolo should be aligned so that the approach to Old Hardin Road is near 90 degrees. If the convenience store is to continue operating, the roadway would have to be moved easterly prior to the intersection approach.

BENEFITS

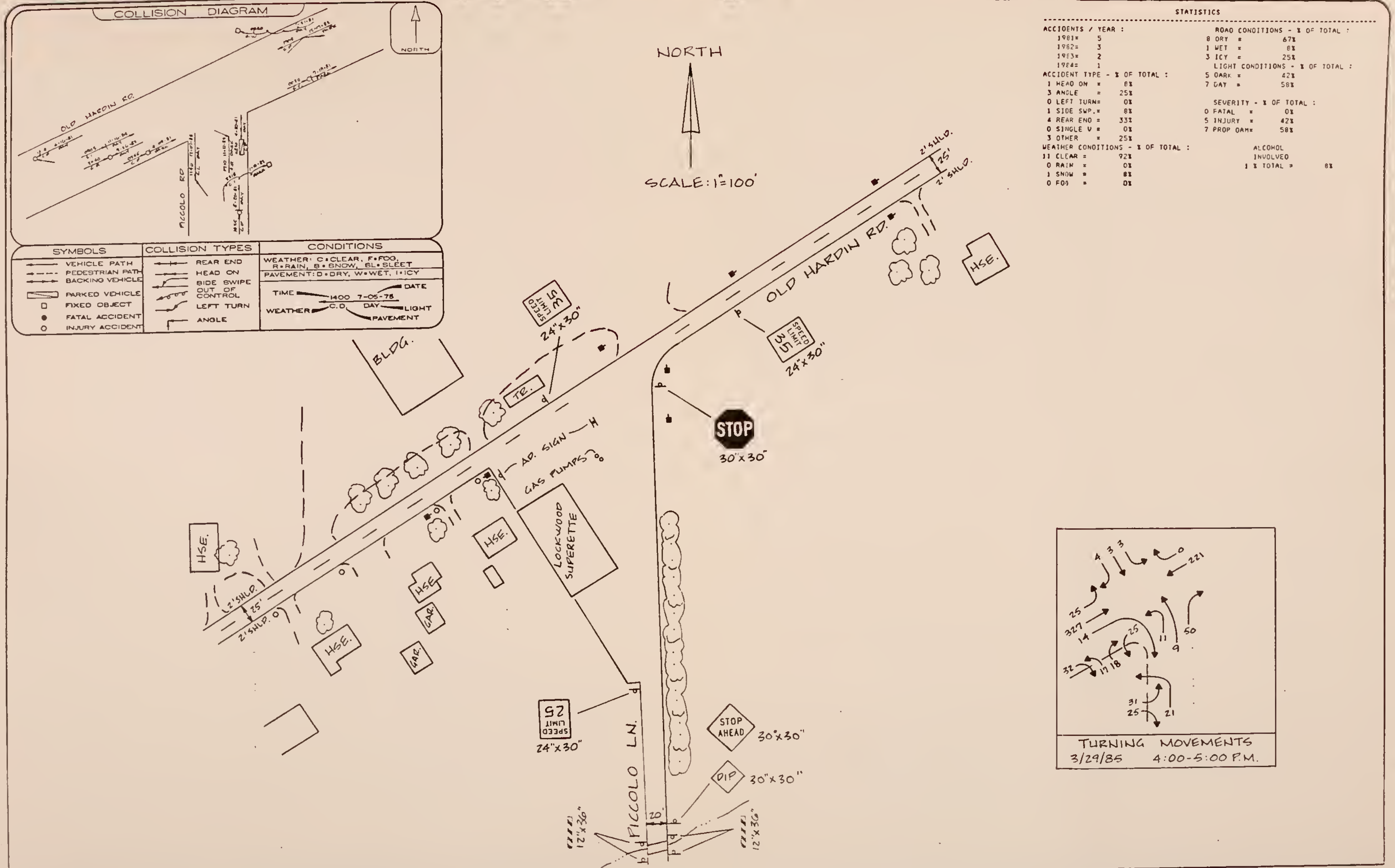
The greatest percentage accident reduction expected from the short term improvements would be predicted for angle accidents, rear end accidents and head on accidents. The basis for anticipated reductions is due mainly to improved access control, advanced warning and positive guidance by delineation.

The annual dollar benefit that may be realized is computed to be approximately $14,500. The benefit/cost ratio would therefore be close to 6. The accident reduction trend that appears to be occurring will probably not continue and therefore it is felt that the benefits are actually obtainable.

FUNDING CONSIDERATIONS

Short term improvements can be funded by established county budget sources, establishment of a special program or by submitting this project into the Department of Highways Off System Safety program for prioritization.

Long term improvements, should either be included in a RSID project with the County contributing a portion of the costs, since Piccolo is a collector street. Improvements could be constructed at the time of future developments with the developer contributing a portion of the costs based on identified impacts.


COLLISION DIAGRAM
NORTH
OLD HARDIN RD.
PICCOLO RD.
SYMBOLS
VEHICLE PATH
PEDESTRIAN PATH
BACKING VEHICLE
PARKED VEHICLE
FIXED OBJECT
FATAL ACCIDENT
INJURY ACCIDENT
COLLISION TYPES
REAR END
HEAD ON
SIDE SWIPE
OUT OF CONTROL
LEFT TURN
ANGLE
CONDITIONS
WEATHER: C=CLEAR, F=FOG, R=RAIN, S=SNOW, SL=SLEET
PAVEMENT: D=DRY, W=WET, I=ICY
TIME 1400 7-05-78 DATE
WEATHER C.D DAY LIGHT
PAVEMENT
NORTH
SCALE: 1"=100'
STATISTICS
ACCIDENTS / YEAR :
1981= 5
1982= 3
1983= 2
1984= 1
ACCIDENT TYPE - % OF TOTAL :
1 HEAD ON = 8%
3 ANGLE = 25%
0 LEFT TURN= 0%
1 SIDE SWP.= 8%
4 REAR END = 33%
0 SINGLE V = 0%
3 OTHER = 25%
WEATHER CONDITIONS - % OF TOTAL :
11 CLEAR = 92%
0 RAIN = 0%
1 SNOW = 8%
0 FOG = 0%
ROAD CONDITIONS - % OF TOTAL :
8 DRY = 67%
1 WET = 8%
3 ICY = 25%
LIGHT CONDITIONS - % OF TOTAL :
5 DARK = 42%
7 DAY = 58%
SEVERITY - % OF TOTAL :
0 FATAL = 0%
5 INJURY = 42%
7 PROP DAM= 58%
ALCOHOL INVOLVED
1 % TOTAL = 8%
2' SHLD.
25'
2' SHLD.
OLD HARDIN RD.
HSE.
SPEED LIMIT 35
24"x30"
SPEED LIMIT 35
24"x30"
BLDG.
TR.
STOP
30"x30"
AD. SIGN
GAS PUMPS
LOCKWOOD SUPERETTE
HSE.
HSE.
GAR.
HSE.
GAR.
HSE.
2' SHLD.
25'
2' SHLD.
SPEED LIMIT 25
24"x30"
PICCOLO LN.
STOP AHEAD
30"x30"
DIP
30"x30"
20'
12"x36"
12"x36"
TURNING MOVEMENTS
3/29/85 4:00-5:00 P.M.

MARVIN & ASSOCIATES
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Project: TRAFFIC SAFETY STUDY– YELLOWSTONE COUNTY ROADS

Sheet Title: OLD HARDIN RD & PICCOLO LN. EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

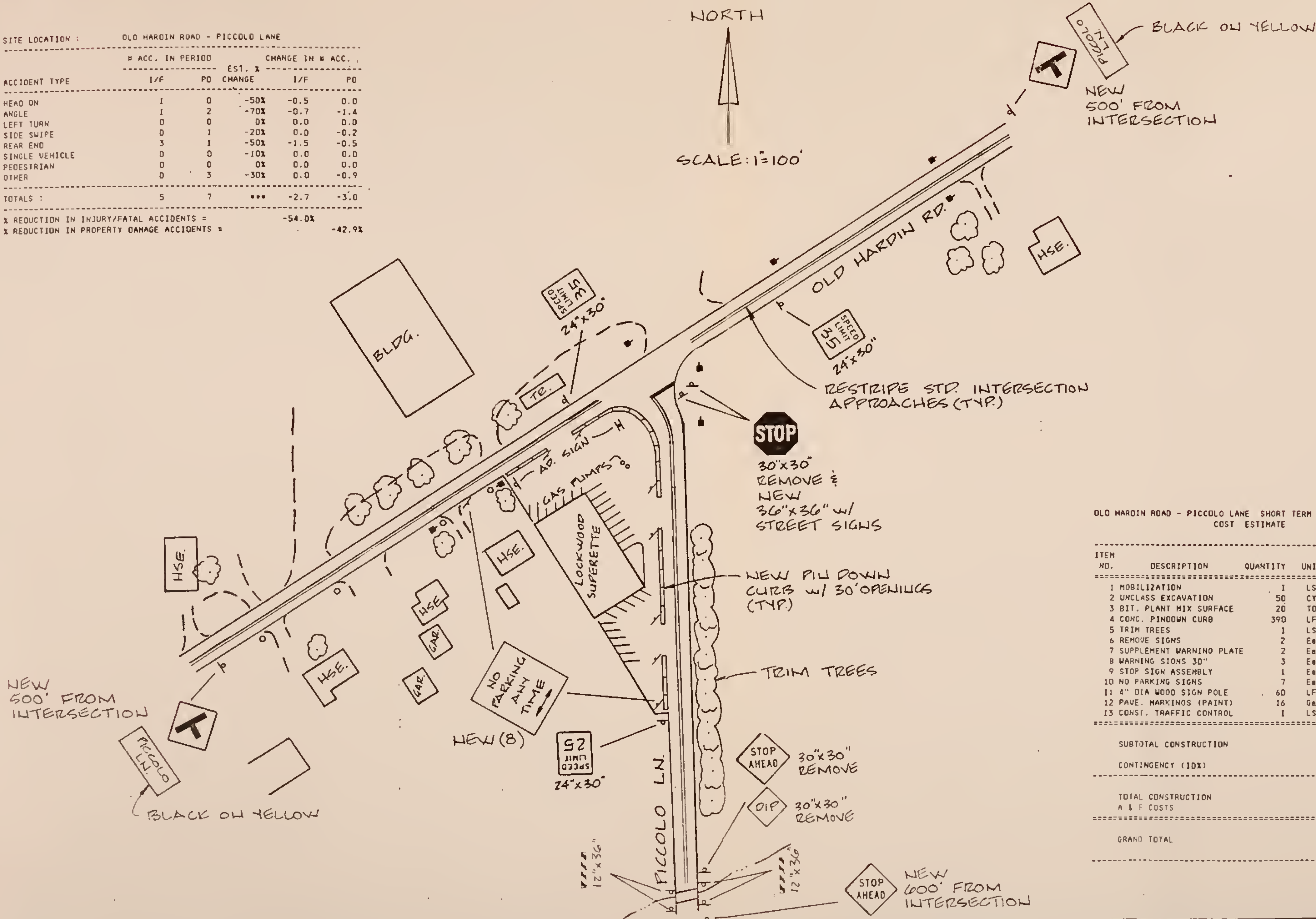
Project No.
Contr. No.
Sheet No.
of

SITE LOCATION : OLD HARDIN ROAD - PICCOLO LANE

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	1	0	-50%	-0.5	0.0
ANGLE	1	2	-70%	-0.7	-1.4
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	1	-20%	0.0	-0.2
REAR END	3	1	-50%	-1.5	-0.5
SINGLE VEHICLE	0	0	-10%	0.0	0.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	3	-30%	0.0	-0.9
TOTALS :	5	7	***	-2.7	-3.0

% REDUCTION IN INJURY/FATAL ACCIDENTS = -54.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -42.9%



OLD HARDIN ROAD - PICCOLO LANE SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1	LS	$200.00	$200.00
2	UNCLASS EXCAVATION	50	CY	$3.50	$175.00
3	BIT. PLANT MIX SURFACE	20	TON	$35.00	$700.00
4	CONC. PINDOWN CURB	390	LF	$8.00	$3,120.00
5	TRIM TREES	1	LS	$200.00	$200.00
6	REMOVE SIGNS	2	Ea	$20.00	$40.00
7	SUPPLEMENT WARNING PLATE	2	Ea	$40.00	$80.00
8	WARNING SIGNS 30"	3	Ea	$80.00	$240.00
9	STOP SIGN ASSEMBLY	1	Ea	$125.00	$125.00
10	NO PARKING SIGNS	7	Ea	$40.00	$280.00
11	4" DIA WOOD SIGN POLE	60	LF	$3.50	$210.00
12	PAVE. MARKINGS (PAINT)	16	Gal	$25.00	$400.00
13	CONST. TRAFFIC CONTROL	1	LS	$1,000.00	$1,000.00
	SUBTOTAL CONSTRUCTION				$6,570.00
	CONTINGENCY (10%)				$657.00
	TOTAL CONSTRUCTION				$7,227.00
	A & E COSTS				$1,445.40
	GRAND TOTAL				$8,672.40

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers

Project: TRAFFIC SAFETY STUDY— YELLOWSTONE COUNTY ROADS

Sheet Title

#7

HIGHWAY 312 - SHEPHERD ROAD INTERSECTION

PRIORITY NUMBER 7

SITE DESCRIPTION

The intersection of Highway 312 and Shepherd Road is one of six separate accident cluster sites along Highway 312 that are included in this study. A detailed discussion regarding Highway 312 can be found within the main body of this report.

Shepherd Road is also described within the priority numbers 2 & 8 site location descriptions. Shepherd Road extends north of the intersection for approximately 6 miles. It also extends south of the site approximately 1 mile but that section is known as Vermillion Road. Shepherd Road is designated as County Route 304.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection has 4 approaches and the the roads intersect at an angle slightly off of 90 degrees. The approach grades are all less than 1% with the exception of the southern approach (Vermillion Road) which has a sharp crest vertical curve approximately 500 feet south of the intersection. The grade south of the vertical curve is approximately 10%. Very limited stopping sight distance is available on either side of the vertical curve.

Roadside ditches along Highway 312 provide 3:1 inslopes while Shepherd Road has the more abrupt 2:1 inslopes. The shoulder of Highway 312 in the southwest quadrant of the intersection has been widened probably to provide for the right turn movement or to allow

room for passing left turning vehicles. In either case it is an inadequate design.

Traffic Control Devices. This is one of the only sites studied that make use of junction signing and route markers. Unfortunately the number, arrangement and location of the route signing does not conform to the MUTCD.

Another feature of this location unique to the sites studied is an intersection beacon (flasher). It operates with a red indication for Shepherd Road and an amber indication for Highway 312.

The only warning sign found at the site was a stop ahead, located on the northern approach. The southern approach, which has a definite sight distance problem, does not have any advance warning.

Standard intersection pavement markings exist at all approaches but all exhibit varying states of wear. The southern approach only has markings within the immediate vicinity of the intersection. No markings exist south of or on the crest vertical curve.

Traffic Volumes. Total entering traffic at this intersection is relatively high with heavy turning movements during the peak hours. During the evening peak hour the eastbound left turn movement is the highest percentage movement at 30% of total approach traffic.

The ADT for Highway 312 is computed to be 3,100 west of Shepherd Road and 2,000 east. On Shepherd Road the ADT is 2,200 north of Highway 312 and 200 south. This would indicate that the north and east legs of the intersection are approximately equal and Shepherd Road is a major contributor to Highway 312 traffic volumes. Traffic is also

characterized by heavy commuter volume peaks between Shepherd and Billings with a high volume of eastbound left turns in the evening and southbound right turns in the morning.

Traffic Operations. The most obvious operational problem observed is associated with the eastbound left turn movement. Prevailing speeds on Highway 312 are typical of high speed rural highways. It is unusual to encounter an intersection with heavy turning movements in this area and the resultant deceleration is more than what would be expected. Vehicles were seen to use the additional pavement width on the south side of the intersection at uncomfortable speeds to avoid a rear end collision with a left turning vehicle.

The southbound approach to the intersection should not present much problem but it is believed that perception of the stop condition is hindered by roadside conditions and the horizon view. The distance to the intersection upon approach appears much farther than it actually is.

Another problem observed was that of large trucks turning at the intersection. Although the radii are fairly large, the trucks cannot infringe on adjacent lanes because of heavy traffic and the turn becomes very tight. Trucks make the turns very slowly and thus delay traffic and increase exposure time to conflicting movements.

Accidents. Observed expectancy and visual problems were directly related to at least 6 of the 9 accidents in the four year reporting period. The majority of accidents occurred on clear and dry roads. One accident condition that is not characteristic of other Highway 312

sites is that the vast majority of accidents occurred during daylight hours. Two reasons for this would be the higher volume of turning movements and the visibility of the intersection at night as compared to daytime lighting conditions.

SHORT TERM IMPROVEMENTS

Improved motorist information is clearly required to improve driver expectancy. The short term improvement sketch details the recommended signs and markings which conform to MUTCD requirements. Advanced warning on all approaches should provide the necessary information concerning intersection control. The proper installation of junction signing and the use of large letter directional guide signs on Highway 312 should eliminate the need for advanced warning signs on those approaches. In addition to advanced warning on Shepherd Road, the stop signs should be oversized (36x36) and positioned to maintain maximum visibility.

The overhead beacon provides very good information to motorists approaching a major intersection. This is apparently true at night as evidenced by the lesser number of accidents at night. During the daylight hours the flashers are all but lost in the horizon conditions. Because of that, it is recommended that 12" lenses be installed which will require new signal heads.

Pavement markings should conform to standard intersection markings and maintained to exhibit uniform visual intensity.

The turning radii should be increased as shown to allow adequate area for truck movements at reasonable operating speeds.

The estimated cost of these improvements is estimated to be

approximately $6,400 based on 1985 unit bid contract prices. The county may be able to effect the recommended improvements if completed with county maintenance forces and wholesale material costs.

LONG TERM IMPROVEMENTS

Long term improvements at this intersection will undoubtedly be required as more development occurs in and around Shepherd, Montana. Improvements to Highway 312 should generally follow the recommendations indicated in the main body of this report but as an interim measure it may be necessary to add auxiliary turn lanes with properly designed transitions and deceleration and storage areas. The auxiliary lanes are not currently warranted but moderate increases in left turning and opposing traffic volumes could easily meet those warrants.

Long term improvements to Shepherd Road will undoubtedly require a wider pavement section. Whether four lane volumes will be reached within the planning period is not known. However, future improvements should anticipate 2-12 foot driving lanes with 10 foot parking lanes. As an interim measure, widening at the intersection area on Shepherd Road could be completed to accommodate auxiliary turn lanes.

BENEFITS

The greatest percentage accident reduction expected from the improvements would be for angle accidents. Since sight distance is apparently not a contributing factor at present, the advanced warning and improved visibility of the flashers may provide a 60% reduction in those type of accidents. A more conservative reduction would be

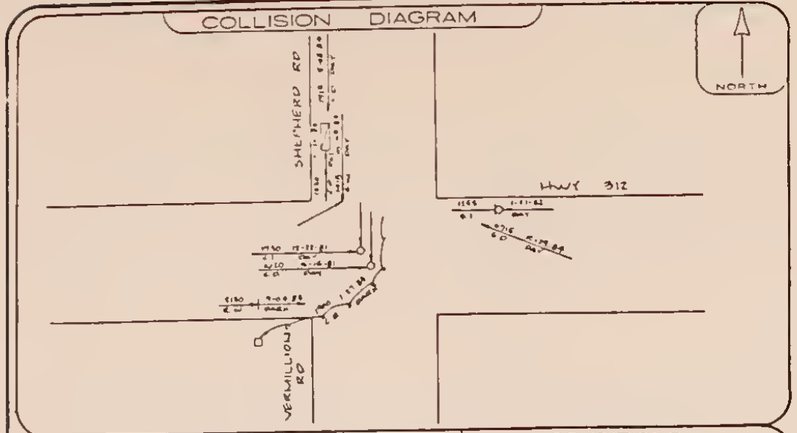
anticipated for other types of accidents.

The annual dollar benefit that may be realized is computed to be approximately $10,000. The benefit/cost ratio would therefore be in excess of 5.

FUNDING CONSIDERATIONS

It is recommended that this project be funded through a special county program or through regular maintenance funds in which case cost may be much lower than estimated. If substantial delay in implementation of these improvements because of funding, submittal of this project into the MDOH statewide, off system safety program should be considered.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 DATE 7-05-75
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 3
- 1982= 3
- 1983= 3
- 1984= 3

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 4 ANGLE = 33%
- 1 LEFT TURN= 8%
- 0 SIDE SWP.= 0%
- 3 REAR END = 25%
- 3 SINGLE V = 25%
- 1 OTHER = 8%

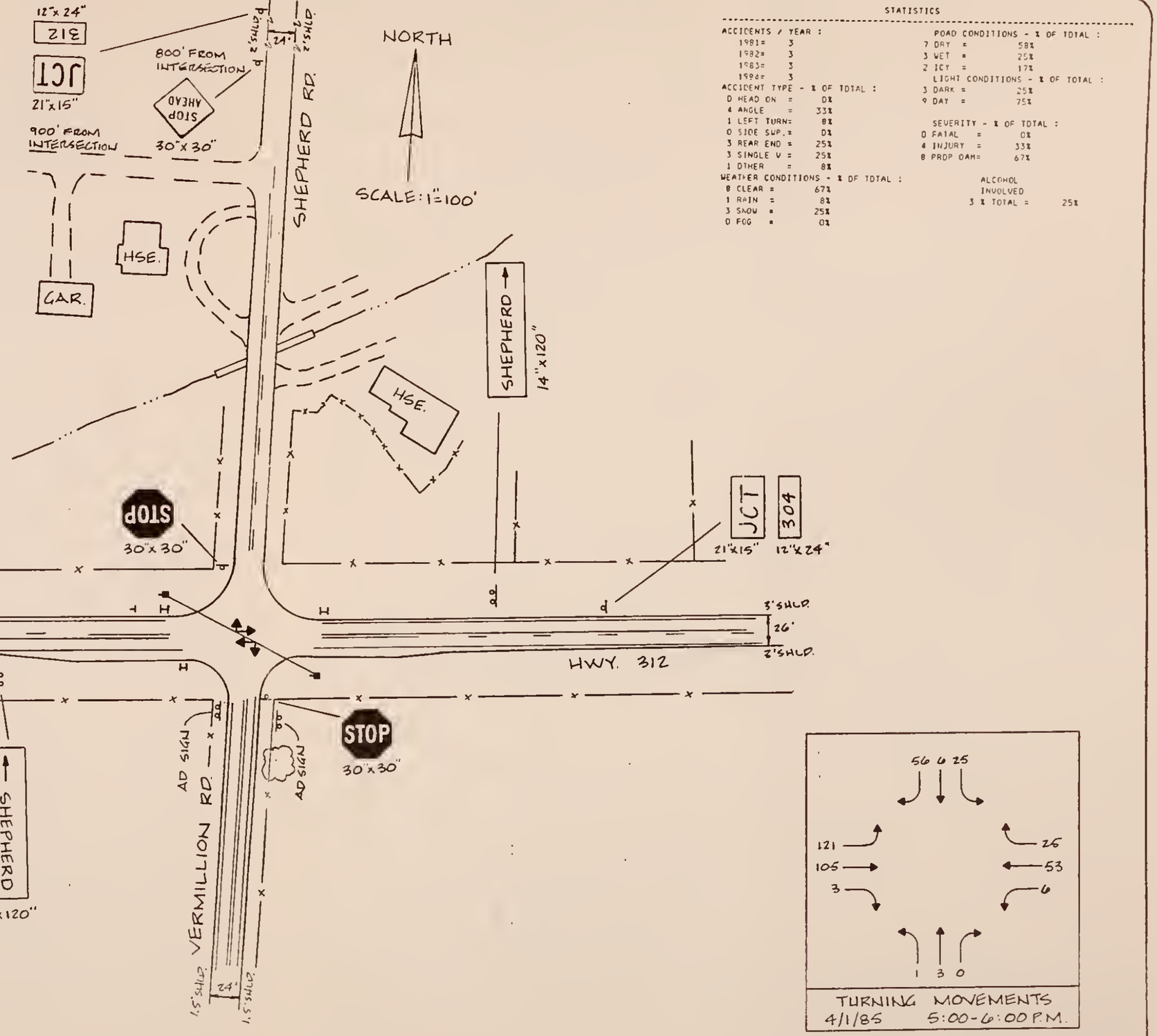
WEATHER CONDITIONS - % OF TOTAL :
- 8 CLEAR = 67%
- 1 RAIN = 8%
- 3 SNOW = 25%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 7 DRY = 58%
- 3 WET = 25%
- 2 ICY = 17%

LIGHT CONDITIONS - % OF TOTAL :
- 3 DARK = 25%
- 9 DAY = 75%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 4 INJURY = 33%
- 8 PROP DAM= 67%

ALCOHOL INVOLVED
3 % TOTAL = 25%



TURNING MOVEMENTS
4/1/85 5:00-6:00 P.M.

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN II
404 N 31st
BILLINGS MT 59101
PH (406) 248-5082

Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: HWY 312 & SHEPHERD RD. EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Sheet No. 01
Count No.

SHORT TERM IMPROVEMENTS

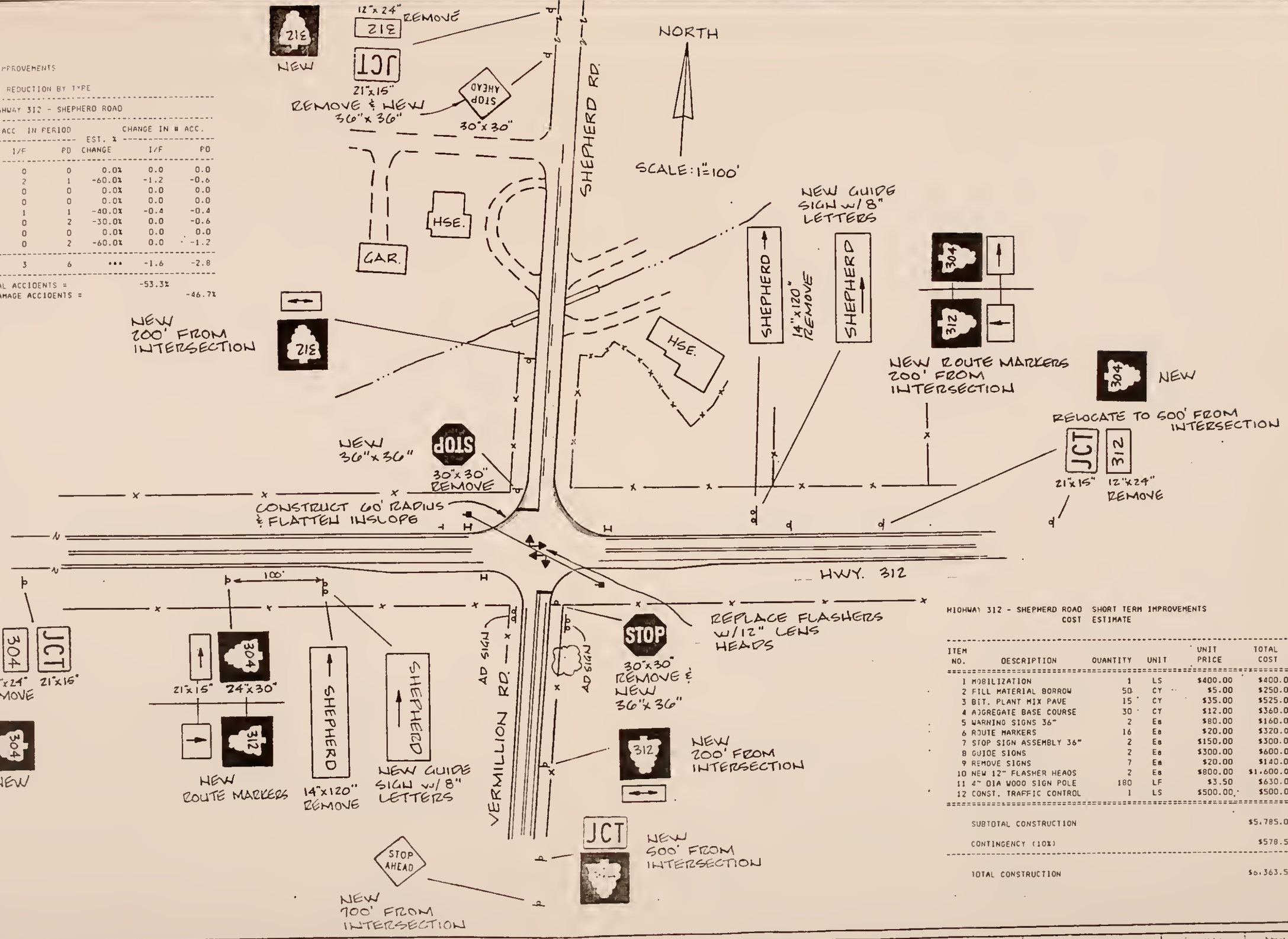
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 312 - SHEPHERD ROAD

ACCIDENT TYPE	# ACC IN PERIOD I/F	# ACC IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	2	1	-60.0%	-1.2	-0.6
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	0	0.0%	0.0	0.0
REAR END	1	1	-40.0%	-0.4	-0.4
SINGLE VEHICLE	0	2	-30.0%	0.0	-0.6
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	0	2	-60.0%	0.0	-1.2
TOTALS :	3	6	•••	-1.6	-2.8

% REDUCTION IN INJURY/FATAL ACCIDENTS = -53.3%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -46.7%



HIGHWAY 312 - SHEPHERD ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1	LS	$400.00	$400.00
2	FILL MATERIAL BORROW	50	CY	$5.00	$250.00
3	BIT. PLANT MIX PAVE	15	CY	$35.00	$525.00
4	AGGREGATE BASE COURSE	30	CY	$12.00	$360.00
5	WARNING SIGNS 36"	2	Ea	$80.00	$160.00
6	ROUTE MARKERS	16	Ea	$20.00	$320.00
7	STOP SIGN ASSEMBLY 36"	2	Ea	$150.00	$300.00
8	GUIDE SIGNS	2	Ea	$300.00	$600.00
9	REMOVE SIGNS	7	Ea	$20.00	$140.00
10	NEW 12" FLASHER HEADS	2	Ea	$800.00	$1,600.00
11	4" DIA WOOD SIGN POLE	180	LF	$3.50	$630.00
12	CONST. TRAFFIC CONTROL	1	LS	$500.00	$500.00
	SUBTOTAL CONSTRUCTION				$5,785.00
	CONTINGENCY (10%)				$578.50
	TOTAL CONSTRUCTION				$6,363.50

MARVIN & ASSOCIATES
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Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: HWY. 312 & SHEPHERD RD. SHORT TERM IMPROVEMENTS

Designed By | Drawn By | Checked By | Date | Remarks | Project No. | Sheet No.

#8

SHEPHERD ROAD - SHEPHERD ROAD EAST INTERSECTION

PRIORITY NUMBER 8

SITE DESCRIPTION

The intersection of Shepherd Road 312 and Shepherd Road East is located approximately 2.5 miles north of Highway 312. This intersection is essentially the main intersection within the community of Shepherd, the business section of Shepherd being west of Shepherd.

The Shepherd-Acton Road is the west leg of the intersection and it extends west of Shepherd approximately 16 miles to Acton, Montana. Shepherd road East only extends 1 mile east on its east-west alignment but it branches to serve a large rural area with a significant number of ranchette type dwellings.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection has 4 approaches and the the roads intersect at 90 degree angles. The approach grades are all less than 1%.

The road surface is elevated approximately 3 feet above the adjacent land and roadside ditches have abrupt 2:1 inslopes. As is with other rural roadways in this area the narrow road surface and abrupt ditch sections leave very little room for driver error.

Three of the four corners of this intersection have either buildings or vegetation which severely limit sight distance.

Traffic Control Devices. A minimum amount of signing exists at this intersection. Stop signs are in place on the Shepherd Road East

and Shepherd-Acton approaches. Intersection warning signs had been installed on Shepherd Road. Apparently past problems with the intersection approach required the installation of those signs because they are oversize.

Advance school warning signs are in place to indicate the presence of Shepherd High School which is on the west side of the road approximately 600 feet south of the intersection.

Only the east approach leg of the intersection has standard pavement markings. The other legs either have lines missing, improper application or in the case of Shepherd-Acton Road, no stripes at all.

Traffic Volumes. Total entering traffic at this intersection is moderate with heavy turning movements during the peak hours. During the evening peak hour the northbound left turn movement is the highest percentage movement.

The ADT for Shepherd Road is computed to be 1,700 south of the intersection and 900 north. On Shepherd Road East the ADT is 1,100 west of the intersection and 500 east. Traffic flow at this intersection is also characterized by heavy commuter volume peaks between the Shepherd area and Billings with a high volume of northbound traffic in the evening and southbound traffic in the morning.

Traffic Operations. The most obvious operational problem observed is associated with the northbound turning movements. Prevailing speeds on Shepherd Road are typical of high speed rural highways. It is very unexpected to encounter an intersection with

heavy turning movements in this area and the resultant deceleration is more than what would be expected. Even vehicles which make a turn, approach the intersection at an uncomfortable speed because the exact location of the intersection is not obvious. Following vehicles intending to proceed straight have little opportunity to avoid a collision if any distraction occurs..

An additional problem related to turning traffic is sharp intersection radii. The pavement is so narrow and abrupt that even passenger vehicles must execute their turns at slower than normal speeds. This causes the required gap acceptance in opposing traffic to be larger than normal. Unfamiliar drivers may not be able to perceive the need for the larger gap and may make errors in judging gap acceptance.

Pedestrian traffic was observed at every occasion that the intersection was visited. The majority of those pedestrian were elementary school age children. At least 50% of the pedestrian mode traffic was bikes. Based on separate and relatively brief observations it appears that the main pedestrian routes are along the west side of Shepherd Road. There is some indication that pedestrians cross Shepherd Road at the intersection. Pedestrian activity on a road of this type is completely unexpected and very few motorists were able to properly react in advance of the encounter.

Accidents. Observed operational deficiencies correlates well with accident experience. Angle accidents, rear end accidents and single vehicle accidents were divide equally. The expectancy and sight distance problems were directly related to rear end and angle

accidents while the single vehicle accidents were indirectly related to the lack of avoidance maneuver area. There was also a pedestrian accident among the 12 accidents.

The majority of accidents occurred on clear and dry roads during the daylight hours.

SHORT TERM IMPROVEMENTS

A variety of improvements are necessary at this intersection. The short term improvements sketch details the recommended improvements. The following is offered as the basis for those recommendations:

1. The intersection control beacon is suggested in response to the highly unexpected nature of the approach. Oversized conventional signing has apparently not provided adequate warning.

2. Regulatory and warning signing improvements should be made to improve visibility and conform to MUTCD.

3. Parking restrictions and relocation of structures is necessary to correct severe sight distance problems.

4. Physical construction of larger turn radii at all corners is necessary not only to increase safety but to improve efficiency.

5. In terms of potential severity, the pedestrian problem is the most critical of all. It has been recommended that pedestrian walks or bike paths be constructed as shown on the sketch. Prior to construction, during the engineering phase of the improvements, a more detailed study of pedestrian traffic and school involvement should be completed to determine the extent of pedestrian facilities required.

The estimated cost of these improvements is estimated to be

approximately $30,800 based on 1985 unit bid contract prices. Because substantial physical construction is involved this project would require a complete engineering design.

LONG TERM IMPROVEMENTS

Long term improvements at this intersection would be required as more development occurs in and around Shepherd, Montana. It would appear from existing traffic volumes and the level of growth that has occurred in the past, that a four lane facility would not be required within the next 10 to 15 years.

Long term improvements to Shepherd Road should require a wider pavement section. The anticipated pavement section should provide 2-12 foot driving lanes with 10 foot parking lanes. The intersection should be widened further to provide auxiliary turn lanes.

BENEFITS

The greatest percentage accident reduction expected from the short improvements would be for angle, side swipe, pedestrian and rear end accidents. Sight distance is a major contributor to angle accidents and improvements in that area are expected to reduce that type by 80%. The advanced warning and emphasis of the intersection location with flashers may provide a significant reduction in the other types of accidents. The most notable benefit, in terms of potential to avert tragic accidents, is improved pedestrian facilities.

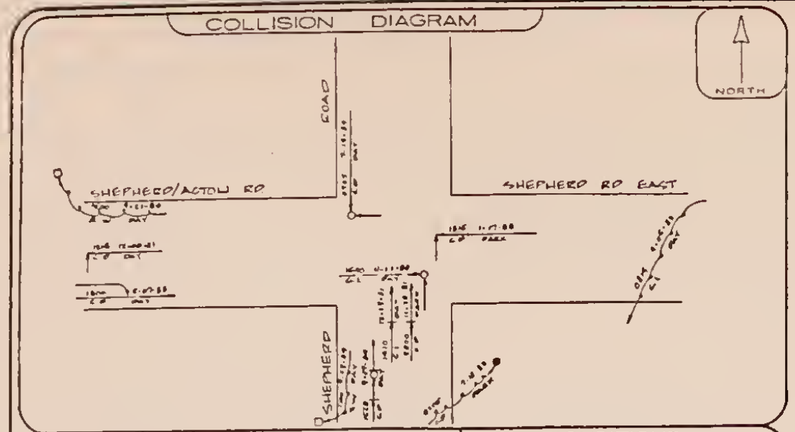
The annual dollar benefit that may be realized is computed to be approximately $17,000. The benefit/cost ratio would therefore be

approximately 2.8, which is substantial for a project involving construction or reconstruction of new facilities.

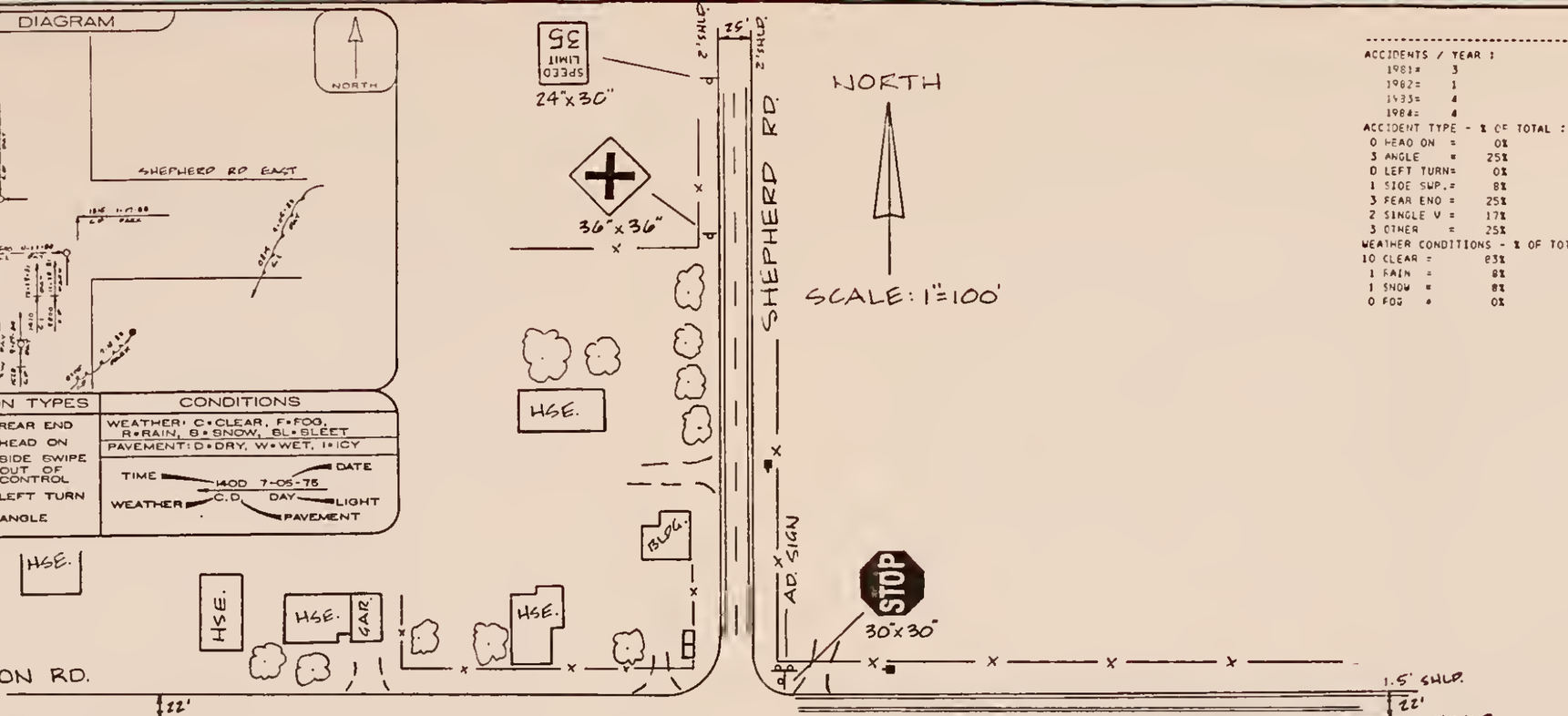
FUNDING CONSIDERATIONS

It is recommended that this project be funded through a special county program or by allocation of annual county road funds. If ther is substantial delay in implementation of these improvements because of funding, submittal of this project into the MDOH statewide, off system safety program should be considered. The nature of this project is such that a Traffic Engineer should be consulted to perform a preliminary design study to determine more definitive criteria for the location and extent of pedestrian facilities. Once determined, the Engineer should prepare plans and specifications for bid letting.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C=CLEAR, F=FOG, R=RAIN, S=SNOW, SL=SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D=DRY, W=WET, I=ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		



STATISTICS

ACCIDENTS / YEAR :
- 1981= 3
- 1982= 1
- 1983= 4
- 1984= 4

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 3 ANGLE = 25%
- 0 LEFT TURN= 0%
- 1 SIDE SWP.= 8%
- 3 REAR END = 25%
- 2 SINGLE V = 17%
- 3 OTHER = 25%

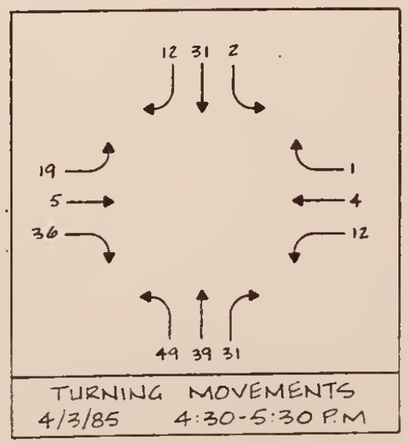
WEATHER CONDITIONS - % OF TOTAL :
- 10 CLEAR = 83%
- 1 RAIN = 8%
- 1 SNOW = 8%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 7 DRY = 58%
- 2 WET = 17%
- 3 ICY = 25%

LIGHT CONDITIONS - % OF TOTAL :
- 3 DARK = 25%
- 9 DAY = 75%

SEVERITY - % OF TOTAL :
- 1 FATAL = 8%
- 3 INJURY = 25%
- 8 PROP DAM= 67%

ALCOHOL INVOLVED
3 % TOTAL = 25%



TURNING MOVEMENTS
4/3/85 4:30-5:30 P.M

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
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404 N. 31st
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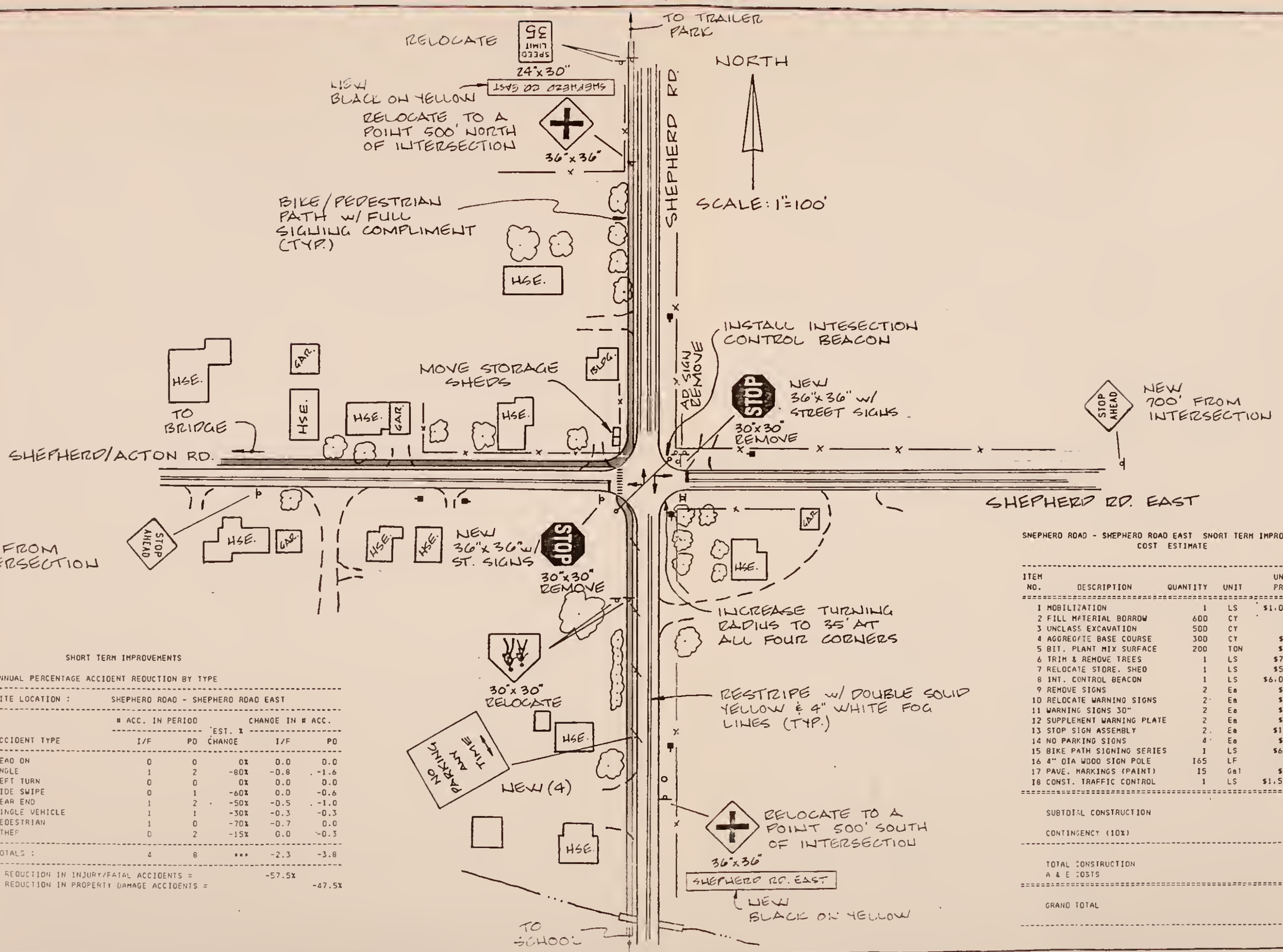
Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: SHEPHERD RD. & SHEPHERD RD EAST EXISTING CONDITIONS

Surveyed By:
Designed By:
Drawn By:
Checked By:
Date:

Revisions
No. Date
No. Date
No. Date
No. Date

Project No:
Code No:
Sheet No:
of



SHEPHERD RD. EAST

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : SHEPHERD ROAD - SHEPHERD ROAD EAST

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0%	0.0	0.0
ANGLE	1	2	-80%	-0.8	-1.6
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	1	-60%	0.0	-0.6
REAR END	1	2	-50%	-0.5	-1.0
SINGLE VEHICLE	1	1	-30%	-0.3	-0.3
PEDESTRIAN	1	0	-70%	-0.7	0.0
OTHER	0	2	-15%	0.0	-0.3
TOTALS :	4	8	***	-2.3	-3.8

% REDUCTION IN INJURY/FATAL ACCIDENTS = -57.5%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -47.5%

SNEPHERD ROAD - SHEPHERD ROAD EAST SNORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1	LS	$1,000.00	$1,000.00
2	FILL MATERIAL BORROW	600	CY	$5.00	$3,000.00
3	UNCLASS EXCAVATION	500	CY	$3.50	$1,750.00
4	AGGREGATE BASE COURSE	300	CY	$12.00	$3,600.00
5	BIT. PLANT MIX SURFACE	200	TON	$35.00	$7,000.00
6	TRIM & REMOVE TREES	1	LS	$700.00	$700.00
7	RELOCATE STORE. SHED	1	LS	$500.00	$500.00
8	INT. CONTROL BEACON	1	LS	$6,000.00	$6,000.00
9	REMOVE SIGNS	2	Ea	$20.00	$40.00
10	RELOCATE WARNING SIGNS	2	Ea	$20.00	$40.00
11	WARNING SIGNS 30"	2	Ea	$80.00	$160.00
12	SUPPLEMENT WARNING PLATE	2	Ea	$40.00	$80.00
13	STOP SIGN ASSEMBLY	2	Ea	$125.00	$250.00
14	NO PARKING SIGNS	4	Ea	$40.00	$160.00
15	BIKE PATH SIGNING SERIES	1	LS	$600.00	$600.00
16	4" DIA WOOD SIGN POLE	165	LF	$3.50	$577.50
17	PAVE. MARKINGS (PAINT)	15	Gal	$25.00	$375.00
18	CONST. TRAFFIC CONTROL	1	LS	$1,500.00	$1,500.00
	SUBTOTAL CONSTRUCTION				$23,332.50
	CONTINGENCY (10%)				$2,333.25
	TOTAL CONSTRUCTION				$25,665.75
	A & E COSTS				$5,133.15
	GRAND TOTAL				$30,798.90

MARVIN & ASSOCIATES
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Billings MT 59101
Traffic Transportation & Civil Engineers
PH (406) 248-2088

Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: SHEPHERD RD. / SHEPHERD RD. EAST SHORT TERM IMPROVEMENTS

Designed By
Detailed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Sheet No.

OLD HARDIN ROAD - DICKIE ROAD INTERSECTION

PRIORITY NUMBER 9

SITE DESCRIPTION

Old Hardin Road is a minor arterial which extends from the Lockwood I-90 Interchange at its western terminus to a point near the Pinehills I-90 Interchange at its eastern terminus. It serves as a northern frontage road to I-90 and provides access to the major portion of the urban area known as Lockwood.

Dickie Road is a local street within a small residential development in Pinehills northeast of the I-90 & I94 interchange. Dickie Road is actually an extension of Old Hardin Road but it could be considered the eastern terminus of Old Hardin Road.

EXISTING CONDITIONS

Geometrics. The existing condition sketch shows that the intersection is more of a curve in a continuous route than an intersection. The curve is not quite 90 degrees and has a gravel approach to a wrecking yard on the outside of the curve.

The Old Hardin Road approach is on an upgrade of approximately 4 % while the Dickie Road approach is on a downgrade of approximately 2 %. The trees and house on the inside of the curve significantly limits sight distance around the curve.

Traffic Control Devices. Existing signing seems to provide adequate warning for the conditions encountered. The signs are well positioned and well maintained. It appears that they may have been

installed within the past two years although no date of installation stickers were found.

Traffic Volumes. Traffic volumes at this site are light and in the range of normal residential street volumes. The ADT on Old Hardin Road-Dickie Road is approximately 900. Traffic on the wrecking yard approach is estimated to be 50 ADT.

Traffic Operations. The only conflict movement that was apparent from observation was the south bound left turn into the wrecking yard approach. The approach is so wide that southbound vehicles on Dickie Road do not have to deviate from their path to enter the approach. Because of that, the vehicle travels in the wrong lane for a short distance. This is potentially a serious problem since the location in which the encroachment occurs is in the most critical part of the curve, as far as sight distance is concerned. This movement is rare due to low traffic volumes. However, even moderate increases in traffic would increase the potential for severe head on accidents

Accidents. The collision diagram and accident statistics table shown on the existing condition sketch indicate that almost all of the accidents are off road single vehicle accidents, typical of curve sections. All of the accidents occurred at night and 50% of them were on icy roads. All but two of the accidents occurred in 1982 and no accidents were reported in 1984. Since the signing appears adequate

and operational observations did not indicate a correlation with the type of accident experienced, it is suspected that the signing was upgraded at this site sometime after 1982.

SHORT TERM IMPROVEMENTS

The short term improvement sketch shows two type of improvements that are recommended. The first involves moving the wrecking yard approach and narrowing its width to force left turning traffic to a point on the curve where adequate sight distance is available. The second type improvement would add extra delineation to the curve which would better define the sharpness of the required maneuvers.

The cost of these improvements is estimated to be approximately $2,500 based on 1985 unit bid contract prices. It is recommended that the improvements, especially the earthwork, be engineered and plans be developed to insure proper geometric controls.

The cost of improved maintenance at this site was added into the annual cost of improvements for calculation of the benefit/cost ratio, since accident experience indicated that loss of control on icy roads was a main contributor to accidents at this site.

No long term improvements can be anticipated for this site since there has not been a history of any significant growth in the immediate area.

BENEFITS

The greatest percentage accident reduction expected from the short term improvements would be predicted for single vehicle accidents based on past accident history. The potential reduction for

head on accidents would have greater implications only if future traffic volumes increase.

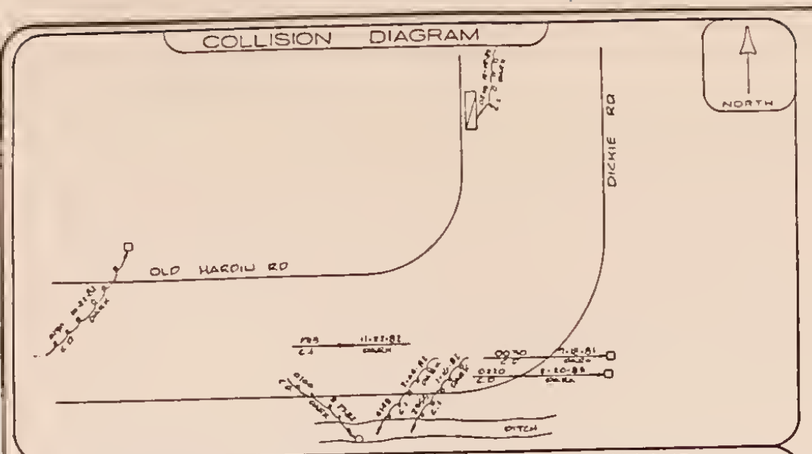
In this situation, improved maintenance is the most critical factor involving a reduction in accidents.

The annual dollar benefit that may be realized is computed to be approximately $4,900. The benefit/cost ratio would therefore be slightly over 3.

FUNDING CONSIDERATIONS

Short term improvements can be funded by established county budget sources or establishment of a special program.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: O•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 1
- 1982= 6
- 1983= 1
- 1984= 0

ACCIDENT TYPE - % OF TOTAL :
- 1 HEAD ON = 13%
- 0 ANGLE = 0%
- 0 LEFT TURN= 0%
- 0 SIDE SWP.= 0%
- 0 REAR END = 0%
- 3 SINGLE V = 38%
- 4 OTHER = 50%

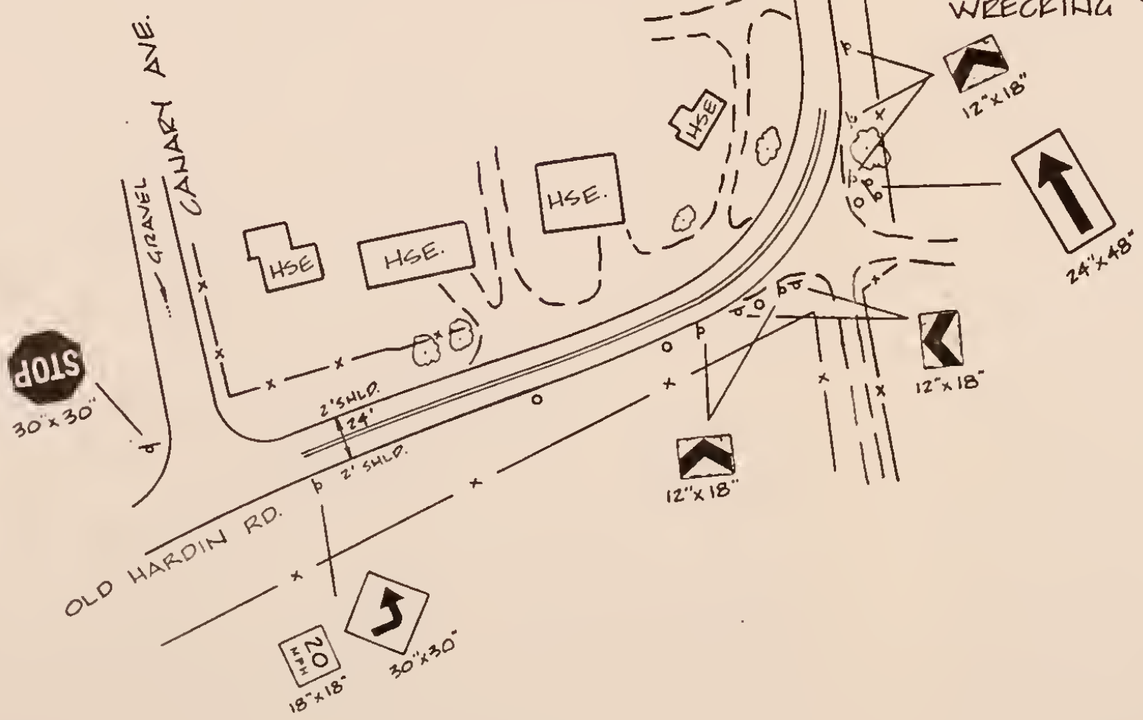
WEATHER CONDITIONS - % OF TOTAL :
- 8 CLEAR = 100%
- 0 RAIN = 0%
- 0 SNOW = 0%
- 0 FOG = 0%

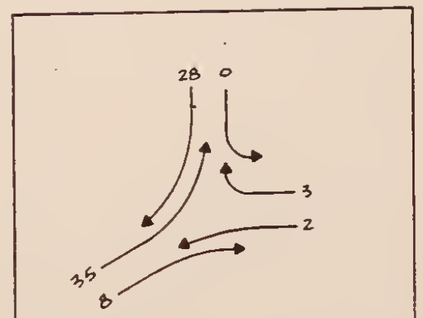
ROAD CONDITIONS - % OF TOTAL :
- 4 DRY = 50%
- 0 WET = 0%
- 4 ICY = 50%

LIGHT CONDITIONS - % OF TOTAL :
- 0 DARK = 0%
- 8 DAY = 100%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 1 INJURY = 13%
- 7 PROP DAM= 88%

ALCOHOL INVOLVED
- 4 % TOTAL = 50%





TURNING MOVEMENTS
4/2/85 1:00-2:00 P.M.

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS, MT. 59107
Ph. (406) 248-5088

Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: OLD HARDIN RD & DICKIE RD EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No Date
No Date
No Date
No Date

Project No

Sheet No.

Card No

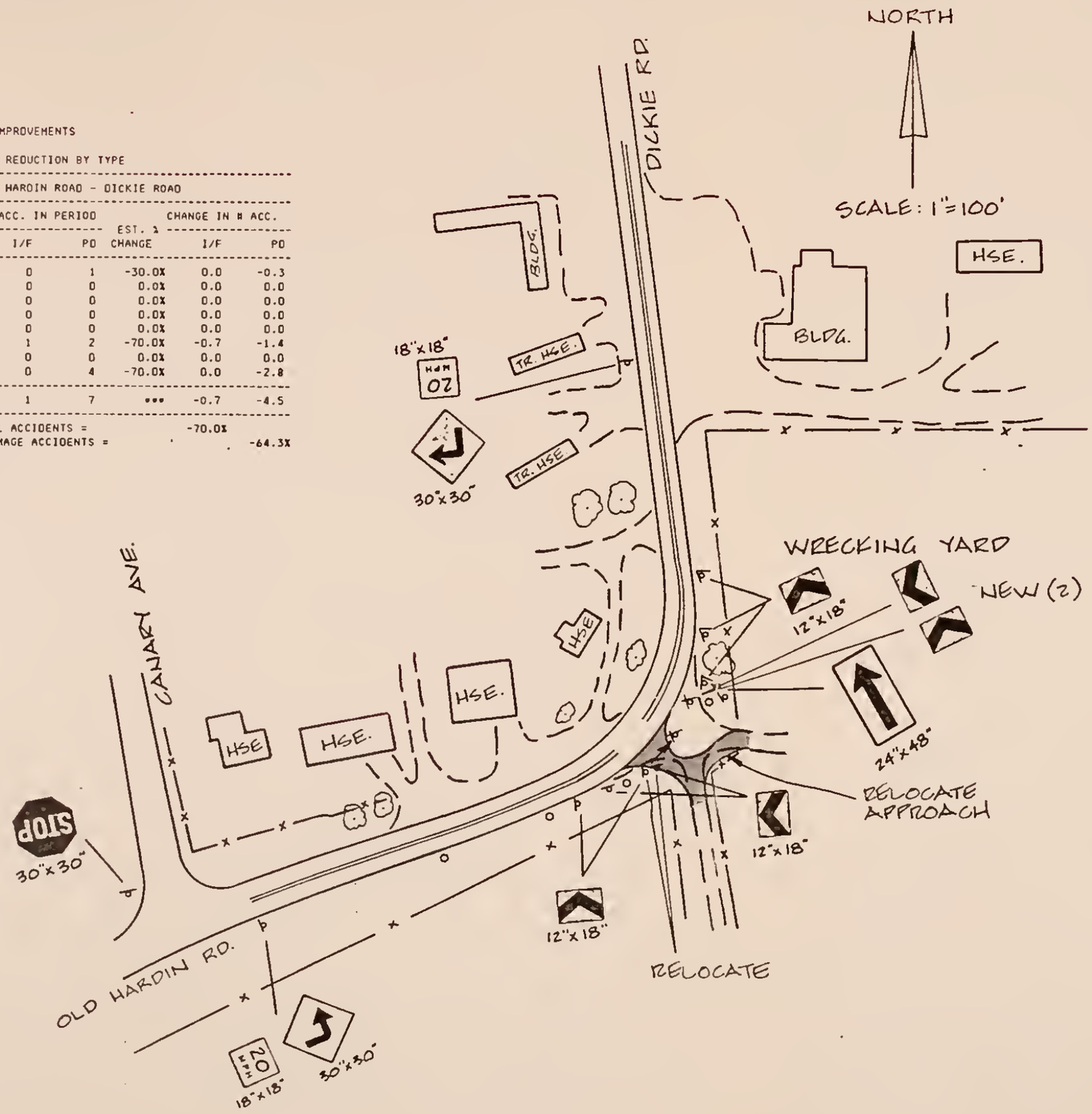
SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : OLD HARDIN ROAD - DICKIE ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	1	-30.0%	0.0	-0.3
ANGLE	0	0	0.0%	0.0	0.0
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	0	0.0%	0.0	0.0
REAR END	0	0	0.0%	0.0	0.0
SINGLE VEHICLE	1	2	-70.0%	-0.7	-1.4
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	0	4	-70.0%	0.0	-2.8
TOTALS :	1	7	***	-0.7	-4.5

% REDUCTION IN INJURY/FATAL ACCIDENTS = -70.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -64.3%



OLD HARDIN ROAD - DICKIE ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	ROADWAY EXCAVATION	120	CY	$3.50	$420.00
2	GRAVEL SURF. MATL.	100	CY	$12.00	$1,200.00
3	CHEVRON MARKERS	7	Ea	$20.00	$140.00
4	4" DIA WOOD SIGN POLES	30	LF	$3.50	$105.00
5	CONST. TRAFFIC CONTROL	1	LS	$350.00	$350.00
	SUBTOTAL CONSTRUCTION				$2,215.00
	CONTINGENCY (10%)				$221.50
	TOTAL CONSTRUCTION				$2,436.50

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: OLD HARDIN RD - DICKIE RD SHORT TERM IMPROVEMENTS

Surveyed By / Designed By / Drawn By / Checked By / Date

Revisions: No. Date

Project No. / Sheet No. / Count No. / of

#10

NEIBAUR ROAD CURVE

PRIORITY NUMBER 10

SITE DESCRIPTION

Neibaur Road is rural type county road which is classified as a Minor Arterial in the Billings Urban Area Transportation plan. Its eastern terminus is at an intersection with Shiloh Road, a major Arterial approximately 1,500 feet east of the site. Neibaur Road extends from that intersection approximately 4.5 miles west. It serves residential subdivisions within the first mile west of Shilo Road and accesses farm land farther to the west. Some light industrial development mainly south of Neibaur is also accessed by this Road.

Proposed projects that may affect the future conditions of Neibaur Road are the new Billings Zoo and the possibility of a new Interstate 90 Interchange. The zoo is located northeast of the site and has access from Shilo Road. The land for this development was dedicated this spring. Interstate 90 which lies south of the site (approximately 200 feet) has been proposed as one of three candidate locations for a new interchange. It is not known whether the interchange would be constructed within the next decade, however the location has been suggested for many years and it would seem that at some point in time funding will be allocated.

EXISTING CONDITIONS

Geometrics. The existing condition sketch shows that the curve has a delta angle of approximately 60 degrees. The access point for Elk River Concrete is located on the outside edge of the curve. The

geometrics of that approach gives it the appearance of a four legged intersection.

South of the site, the industrial property has quite a large storage area for concrete pipes that abut the roadway. The concrete products are large and are with 10 to 15 feet of the shoulder. North of the site a residential subdivision is offset from the roadway by 100 feet and more. Access points to the subdivision are on either end of the curve. Sight distance is adequate for prevailing speeds.

The narrowest part of the roadway is unfortunately within the curve. At one point it is approximately 21 feet wide. There is not adequate superelevation around the curve. It is essentially a reverse crown. The inside shoulder pavement is also raveling and broken which also reduces the effective width of the roadway within the curve section.

Roadside ditches are fairly flat. However there is an irrigation ditch that parallels the south edge of the roadway.

Traffic Control Devices. Existing signing consists of warning devices relating to the curve alignment. The advanced warning signs are not highly visible in the day and have lost some of their reflectivity at night. The directional arrows and chevrons are misplaced and do little to guide motorists through difficult geometrics. Two barricades are in the location where warning arrows should be. The barricades were probably installed to protect or warn motorist of the larger pipes piled near the road. This is a misapplication of barricades and they only serve to misinform and confuse the driver.

No pavement markings were evident at the site.

Traffic Volumes. Traffic volumes at this site are light for a minor arterial road. The estimated ADT is 1,300. Traffic from the Elk River Concrete approach is very light. During observation periods no vehicles entered or exited from the approach.

Traffic Operations. The geometrics of the curve, roadway width and misleading signing all combine to provide a serious expectancy problem. Even though the advisory speed is posted the motorists judgement dominates and most vehicles traverse the curve beyond a comfortable speed. The Elk River approach width and location at the curve is detrimental in providing clues to the driver.

The concrete pipes not only provide a serious roadside hazard but the shear mass and proximity definitely influence operations. They tend to attract attention away from the normal features that drivers perceive and actually camouflage signing and delineation.

Accidents. The collision diagram and accident statistics table shown on the existing condition sketch indicate that almost all of the accidents are off road single vehicle accidents typical of curve sections. The only other type accident was a head on which is also typical of curve sections. All but one of the accidents occurred at night.

Severity is quite high because of the roadside conditions. If it were not for the irrigation ditch the severity may have been higher. Vehicles hit the ditch and were stopped prior to hitting the mass of concrete pipes.

SHORT TERM IMPROVEMENTS

The short term improvement sketch shows that minor reconstruction of the curve is required to provide a feasible level of improvement. Also, the approach to Elk River Concrete should be modified to accommodate signing and to provide access which conforms with driver expectancy.

New signing, properly located, is required for increased visibility and to correct existing deficiencies. New delineation and pavement markings will provide substantially more guidance.

Recommendations for the roadside hazards were not included on the sketch but it is recommended that the county contact Elk River Concrete to determine if the concrete materials could be set back an additional 10 to 15 feet or if a large fence could be erected to improve the visual interference. If the county cannot work out the mechanism to solve this problem, it is recommended that Jersey Guardrail be installed on the outside of the curve. The guardrail should be installed as far from the roadway as is practical to avoid creating another roadside hazard.

The cost of these improvements is estimated to be approximately $19,300 based on 1985 unit bid contract prices. It is recommended that the improvements be engineered and plans be developed to insure proper geometric controls.

LONG TERM IMPROVEMENTS

The exact implications of future developments in the area on Neibaur Road is not known. However, there is sufficient vacant land on the inside of the curve to design a much less severe curve. It is recommended that the county reserve that area for future road construction by any means possible. Depending on the rate of future traffic growth on Neibaur Road it may be that construction of a larger radius curve would be a feasible alternative to the recommended short term improvement.

BENEFITS

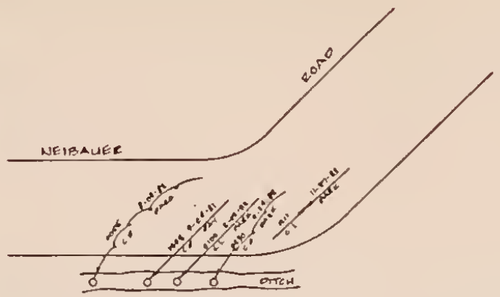
The percentage accident reduction is optimistically estimated at 80% from the short term improvements based on the accident history.

The annual dollar benefit that may be realized is computed to be approximately $18,000. The benefit/cost ratio would therefore be slightly over 4. This ratio is very good for a reconstruction project. Depending on the cost of right of way, the long term improvement of total reconstruction may be in excess of 1.0 and could also be considered as an alternative project at this site.

FUNDING CONSIDERATIONS

Short term improvements can be funded by established county budget sources or by establishment of a special program. This project is also of such a magnitude that MDOH off system safety funding should also be considered for both short term and long term improvements.

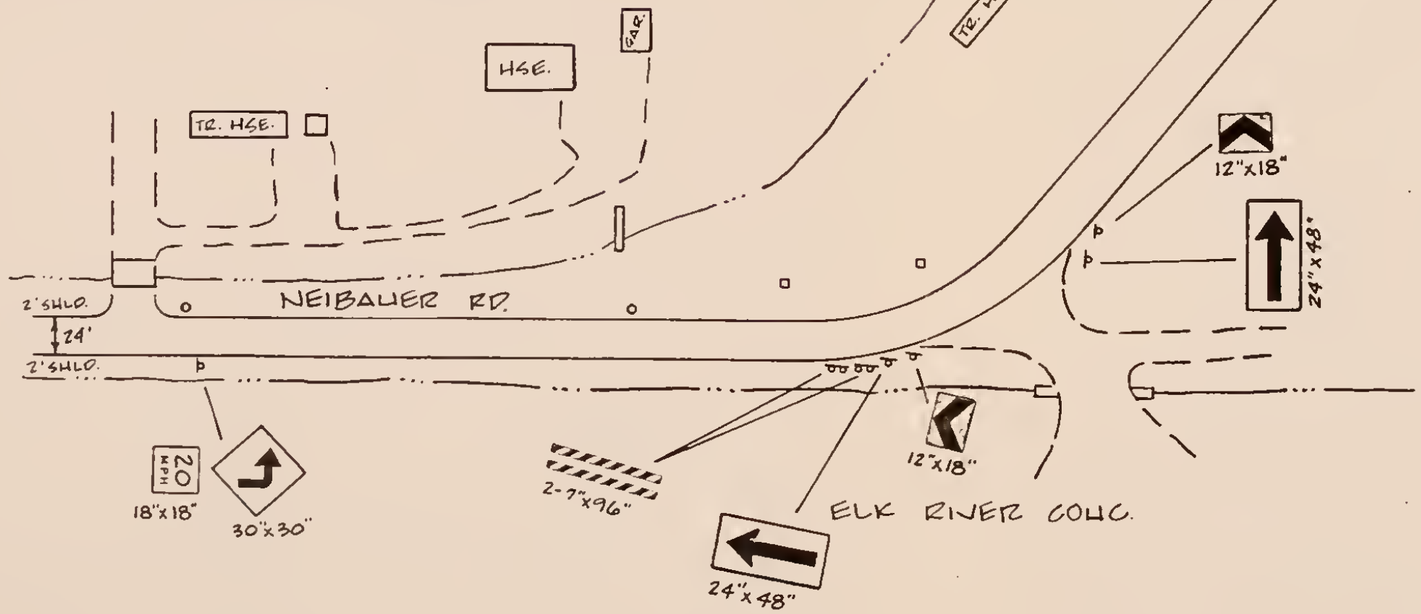
COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, BL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

NORTH

SCALE: 1"=100'



STATISTICS

ACCIDENTS / YEAR :
- 1981= 1
- 1982= 2
- 1983= 2
- 1984= 0

ACCIDENT TYPE - % OF TOTAL :
- 1 HEAD ON = 20%
- 0 ANGLE = 0%
- 0 LEFT TURN= 0%
- 0 SIDE SWP.= 0%
- 0 REAR END = 0%
- 4 SINGLE V = 80%
- 0 OTHER = 0%

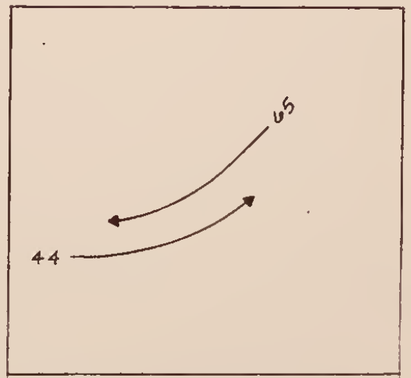
WEATHER CONDITIONS - % OF TOTAL :
- 4 CLEAR = 80%
- 0 RAIN = 0%
- 1 SNOW = 20%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 3 DRY = 60%
- 0 WET = 0%
- 2 ICY = 40%

LIGHT CONDITIONS - % OF TOTAL :
- 4 DARK = 80%
- 1 DAY = 20%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 4 INJURY = 80%
- 1 PROP DAM= 20%

ALCOHOL INVOLVED
- 4 % TOTAL = 80%



TURNING MOVEMENTS
3/18/85 3:30-4:30 P.M.

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: NEIBAUER ROAD EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Contr. No.
Sheet No.
of

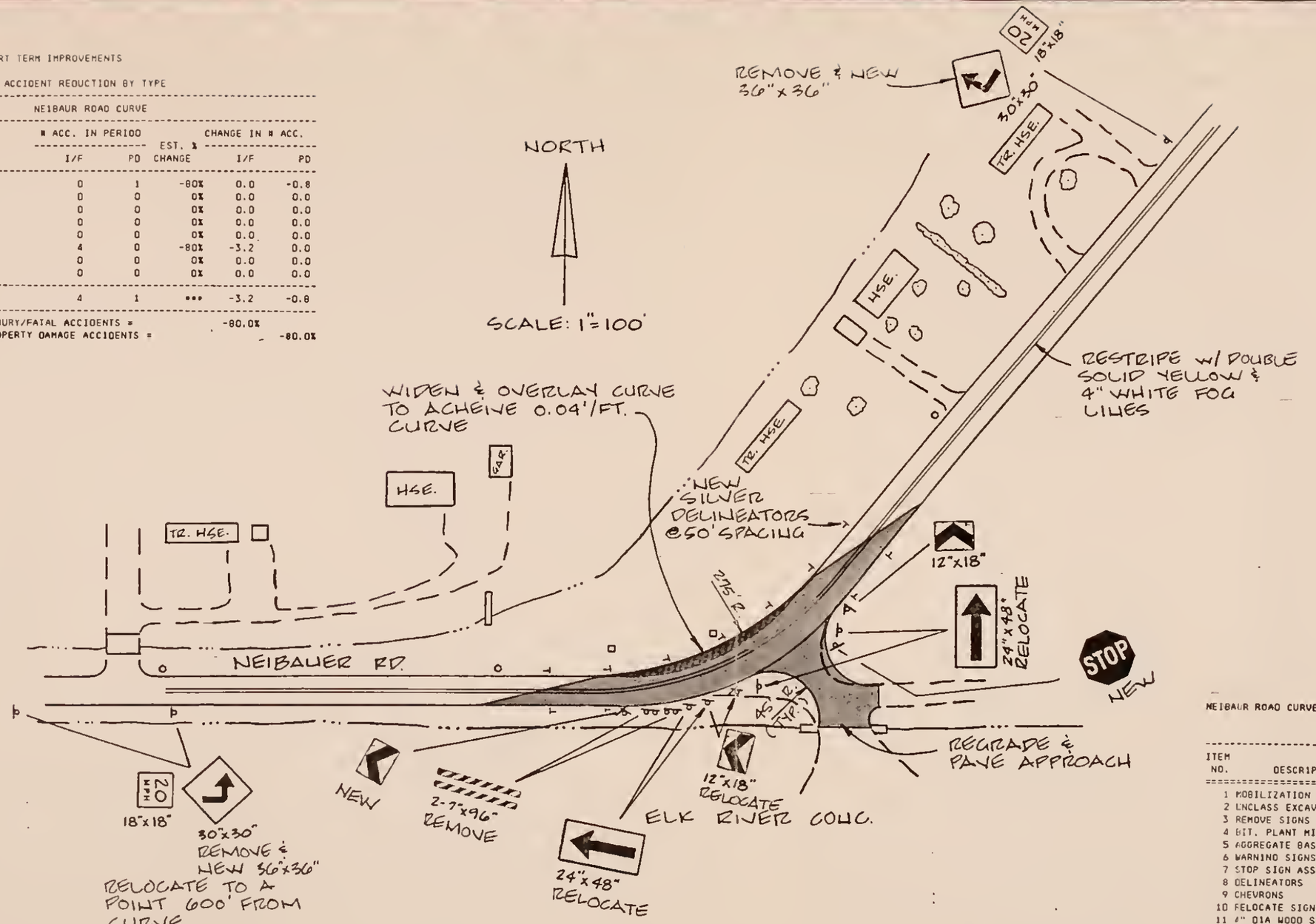
SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : NEIBAUR ROAD CURVE

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	1	-80%	0.0	-0.8
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	4	0	-80%	-3.2	0.0
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	0	0%	0.0	0.0
TOTALS :	4	1	•••	-3.2	-0.8

% REDUCTION IN INJURY/FATAL ACCIDENTS = -80.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -80.0%



NEIBAUR ROAD CURVE SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1	LS	$400.00	$400.00
2	UNCLASS EXCAVATION	200	CY	$3.50	$700.00
3	REMOVE SIGNS	3	Ea	$20.00	$60.00
4	BIT. PLANT MIX PAVING	300	TON	$35.00	$10,500.00
5	AGGREGATE BASE CRSE.	120	CY	$12.00	$1,440.00
6	WARNING SIGNS 36"	2	Ea	$100.00	$200.00
7	STOP SIGN ASSEMBLY	1	Ea	$125.00	$125.00
8	DELINEATORS	12	Ea	$10.00	$120.00
9	CHEVRONS	5	Ea	$20.00	$100.00
10	RELOCATE SIGNS	3	Ea	$20.00	$60.00
11	4" DIA WOOD SIGN POLE	30	LF	$3.50	$105.00
12	PAVEMENT MARKINGS	12	Gal	$25.00	$300.00
13	CONST. TRAFFIC CONTROL	1	LS	$950.00	$600.00
	SUBTOTAL CONSTRUCTION				$14,710.00
	CONTINGENCY (10%)				$1,471.00
	TOTAL CONSTRUCTION				$16,181.00
	SID ADMIN. & ENGINEERING				$3,236.20
	GRAND TOTAL				$19,417.20

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Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: NEIBAUER RD CURVE SHORT TERM IMPROVEMENTS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.

Sheet No.

#11

JELLISON ROAD CURVE

PRIORITY NUMBER 11

SITE DESCRIPTION

Jellison Road is rural type county road which serves as the access road to the City-County Landfill. Its eastern terminus is at an intersection with Secondary Route 416 (Blue Creek Road) approximately 600 feet east of the site. It extends from that intersection approximately 1.0 mile to the west. The landfill Road is its western terminus. Some degree of residential development is also accessed by Jellison Road.

EXISTING CONDITIONS

Geometrics. The existing condition sketch shows that the curve has a delta angle of approximately 90 degrees. The accident cluster site is immediately preceded by a reverse curve east of the subject curve. While no accidents were reported on the preceding curve, its location definitely contributes to the overall operations at the site. The reverse curves begin very near the Blue Creek Road intersection east of the site. The roadway west of the site is on a tangent section.

Very large trees and residences are among the roadside features at this site. Roadside ditches are almost nonexistent along most of the length. Drainage problems are evidenced by dirt and mud infringements onto the paved shoulders.

Several approaches to the roadway within the curves exist. The site photos, even though exaggerated by a telephoto lens shows that

there are extreme sight distance problems.

Traffic Control Devices. The only existing signing is a warning sign for the eastbound curve approach. This sign assembly is entirely non reflective and is so dirty at times that it is not legible during daylight hours.

Traffic Volumes. Traffic volumes at this site are relatively heavy for a rural access road. The estimated ADT is 2,200. The percentage is quite high, approximately 25%. The truck traffic is mostly large garbage trucks and larger transfer vehicles.

Traffic Operations. The geometrics of the curve and roadside features exceed driver expectancy even for motorists who have made occasional trips through the area. It was observed that the majority of vehicle traverse the curve quite a bit faster than what would normally be considered comfortable. At least 60 % of all vehicles on the roadway cross what would be considered the centerline because of the excess speed.

Accidents. The collision diagram and accident statistics table shown on the existing condition sketch indicate that the majority of the accidents are side swipe accidents. The head on and the off road accidents in additions to the side swipes are all directly related to the roadway geometrics.

SHORT TERM IMPROVEMENTS

The short term improvement sketch shows that minor reconstruction to widen the curve is required to provide a feasible level of improvement. Also a full complement of warning signs and delineation is recommended. Some degree of improvement would be realized if just the signing were implemented but it is felt that more maneuver room is necessary since improvements to sight distance cannot feasibly be made. Collisions involving vehicles traveling in opposite direction may continue to occur unless the extra margin of curve widening is not provided.

The cost of these improvements is estimated to be approximately $16,600 based on 1985 unit bid contract prices. It is recommended that the improvements be engineered and plans be developed to insure proper geometric controls.

LONG TERM IMPROVEMENTS

It is not expected that future traffic volumes will be significantly greater than exist because the amount of land remaining to be developed is limited. However, the short term improvements cannot be considered ultimate. it is recommended that the county at least be cognizant of the problems in this area and incorporate a project to realign the roadway in their planning endeavors.

BENEFITS

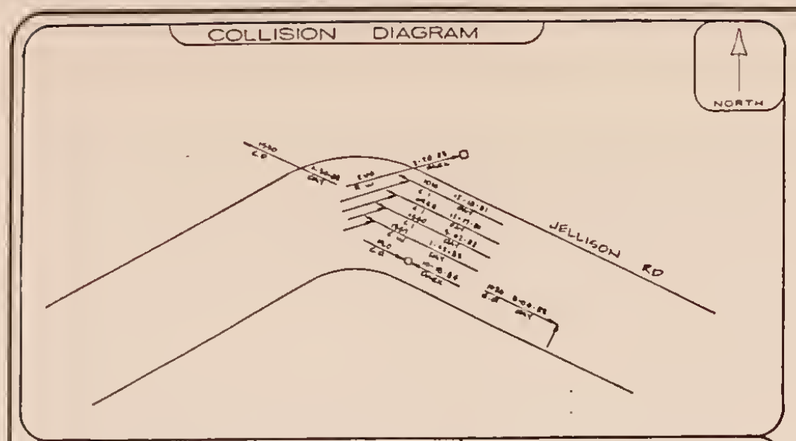
The percentage accident reduction resulting from the short term improvements is estimated at 80 % based on the accident history.

The annual dollar benefit that may be realized is computed to be approximately $6,200. The benefit/cost ratio would therefore be approximately 2. This ratio is also very good for a reconstruction project.

FUNDING CONSIDERATIONS

Short term improvements can be funded by established county budget sources or by establishment of a special program. This project is adjacent to a proposed MDOH project at the intersection of Blue Creek and Jellison Road. The possibility of combining these projects should also be investigated.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 2
- 1982= 2
- 1983= 3
- 1984= 1

ACCIDENT TYPE - % OF TOTAL :
- 1 HEAD ON = 13%
- 1 ANGLE = 13%
- 0 LEFT TURN= 0%
- 4 SIDE SWP.= 50%
- 0 REAR END = 0%
- 1 SINGLE V = 13%
- 1 OTHER = 13%

WEATHER CONDITIONS - % OF TOTAL :
- 7 CLEAR = 88%
- 1 RAIN = 13%
- 0 SNOW = 0%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 3 DRY = 38%
- 2 WET = 25%
- 3 ICY = 38%

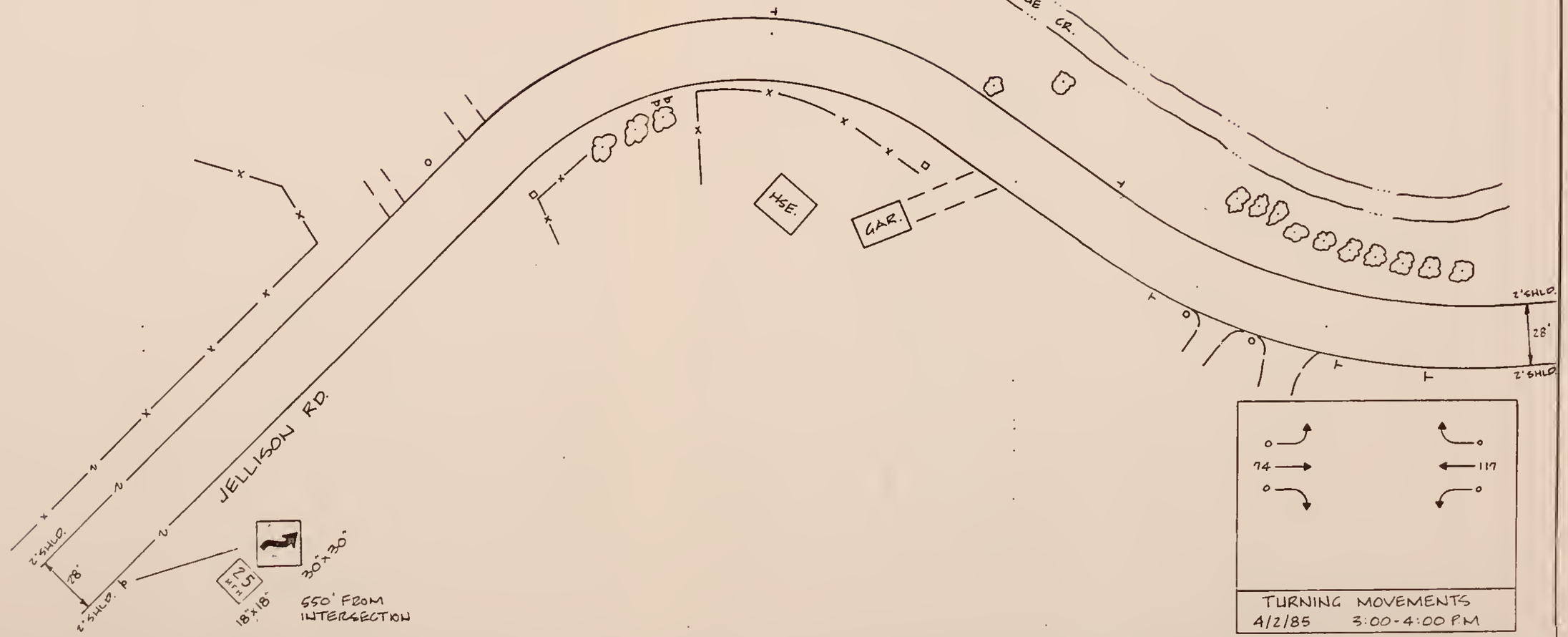
LIGHT CONDITIONS - % OF TOTAL :
- 2 DARK = 25%
- 6 DAY = 75%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 1 INJURY = 13%
- 7 PROP DAM= 88%

ALCOHOL INVOLVED
1 % TOTAL = 13%

NORTH

SCALE: 1"=50'



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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: JELLISON RD CURVE EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Sheet No.
of

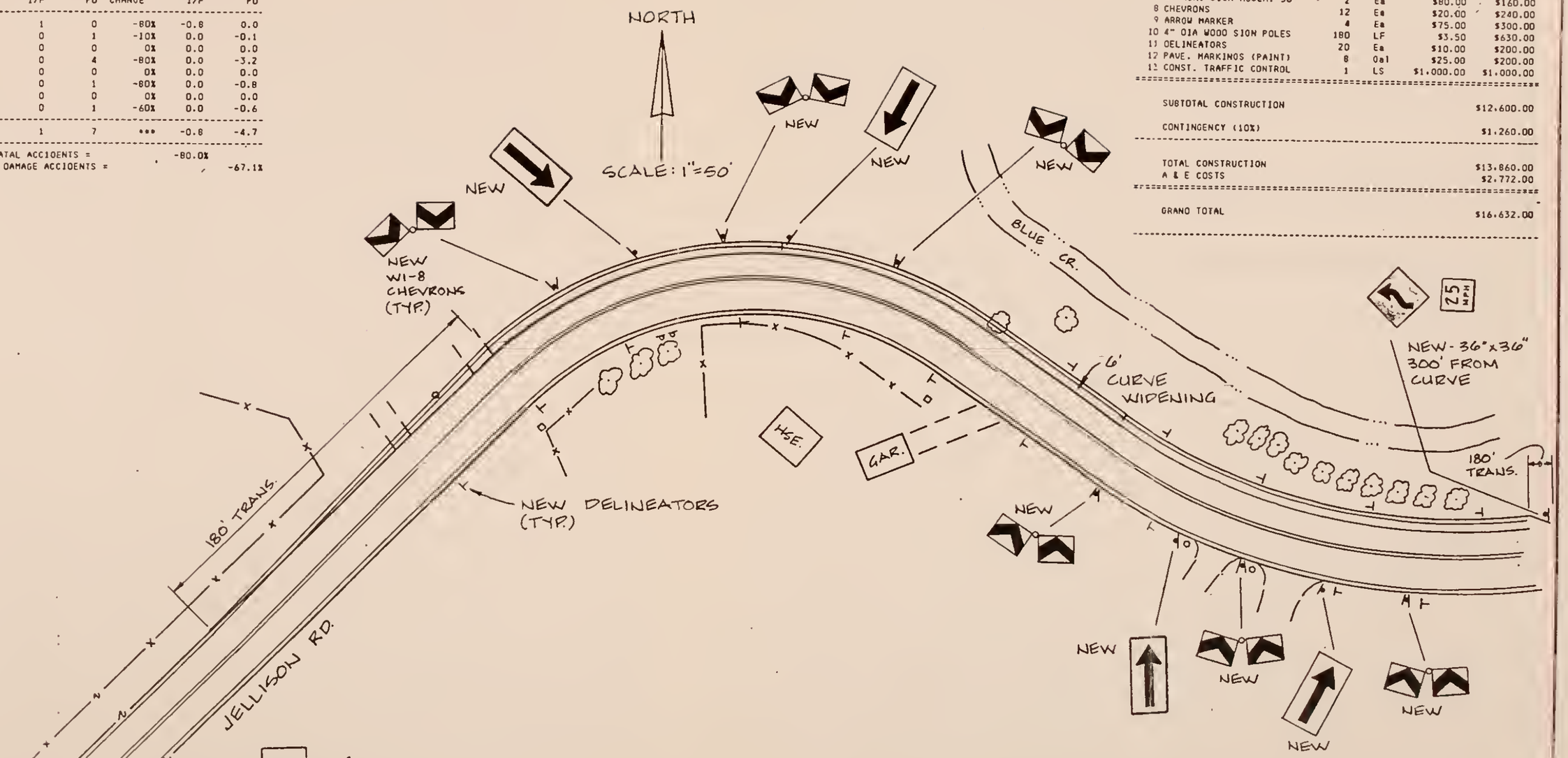
SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : JELLISON ROAD CURVE

ACCIDENT TYPE	# ACC. IN PER100 I/F	# ACC. IN PER100 PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	1	0	-80%	-0.8	0.0
ANGLE	0	1	-10%	0.0	-0.1
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	4	-80%	0.0	-3.2
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	0	1	-80%	0.0	-0.8
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	1	-60%	0.0	-0.6
TOTALS :	1	7	***	-0.8	-4.7

% REDUCTION IN INJURY/FATAL ACCIDENTS = -80.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -67.1%



JELLISON ROAD CURVE SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1	LS	$500.00	$500.00
2	UNCLASS. EXCAVATION	100	CY	$3.50	$350.00
3	FILL MAT'L BORROW	500	CY	$5.00	$2,500.00
4	BIT. PLANT MIX PAVING	100	TON	$35.00	$3,500.00
5	AGGREGATE BASE CRSE.	250	CY	$12.00	$3,000.00
6	REMOVE SIGNS	1	Ea	$20.00	$20.00
7	WARNING SIGN ASSEM. 36"	2	Ea	$80.00	$160.00
8	CHEVRONS	12	Ea	$20.00	$240.00
9	ARROW MARKER	4	Ea	$75.00	$300.00
10	4" DIA WOOD SIGN POLES	180	LF	$3.50	$630.00
11	DELINEATORS	20	Ea	$10.00	$200.00
12	PAVE. MARKINGS (PAINT)	8	Gal	$25.00	$200.00
13	CONST. TRAFFIC CONTROL	1	LS	$1,000.00	$1,000.00
	SUBTOTAL CONSTRUCTION				$12,600.00
	CONTINGENCY (10%)				$1,260.00
	TOTAL CONSTRUCTION				$13,860.00
	A & E COSTS				$2,772.00
	GRAND TOTAL				$16,632.00

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Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: JELLISON RD CURVE SHORT TERM IMPROVEMENTS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Sheet No.
Case No.

#12

DOVER ROAD - PIONEER ROAD INTERSECTION

PRIORITY NUMBER 12

SITE DESCRIPTION

Dover Road and Pioneer Road are rural county roads which intersect southeast of Highway 312 and north of Billings. Both roads are within the Urban Transportation Planning boundaries and are classified as future minor arterials.

Dover road begins at an intersection with Highway 312 approximately 1.5 miles west of the site and extends past the intersection to a point approximately 0.5 miles east. Pioneer Road begins at the intersection site and continues north approximately 1.5 miles to its terminus at Highway 312 and Drury Lane.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection has unique geometrics. The alignment and operation of the intersection gives continuity of route along a 90 degree curve between the north leg (Pioneer Road) and the west leg (Dover Road). The continuation of Dover Road to the east is a gravel road offset from the west leg alignment and is very minor leg of the intersection. A fourth leg of the intersection is actually an approach to Pioneer School, a rural elementary school.

The curved section of the intersection has a 6 % superelevation rate with a steep embankment dropping off into the school parking area. The roadside ditches along both roads are steep and abrupt as is the case with most of the rural roads in the area.

The approach grades are all less than 1% with the exception of the gravel section of Dover Road which has an abrupt rise to match the elevation of the outside curve shoulder.

A second approach to the school is located west of the intersection. It is over a hundred feet wide and drops off the paved shoulder to the gravel parking area. The gravel parking area is approximately 50 feet wide and vehicles are parked perpendicular to the roadway.

Traffic Control Devices. Most of the signing at the intersection appears to have been installed within the past two to three years because of the excellent condition they are in. A few older signs also exist within the intersection area.

A mixture of warning signs certainly attracts the motorists attention but the message is lost due to the multiple warnings given. The diamond shaped sign indicating the approach to a gravel pit is illegal since it is clearly an advertising sign. Attention is also divided between the advanced school sign and the curve warning signs. The advanced school warning has a regulatory speed limit sign mounted on the same post. Even if the proper procedures were performed in setting that speed limit, the signing does not comply with MUTCD.

On the southbound approach the advanced school warning sign completely blocks the advanced curve sign. This approach is further jeopardized since the warning arrow at the end of the curve is the wrong application for the situation and it is not placed in the line of sight of approaching vehicles.

There appears to have been pavement markings through the intersection area at one time. At present only the fog lines are apparent. The centerline striping was worn to the extent of not being visible.

Traffic Volumes. Total entering traffic at this intersection is very light, approximately 200 ADT. Two different counting periods were represented. One during the evening hour and one during the afternoon school dismissal period. Not all turning movements were represented during any one period. It was apparent that significant peaks do not occur at this location and volumes most likely are consistent throughout the day.

Traffic and pedestrian counts during the afternoon indicated that all students are either bussed or picked up by parents. No children walked or rode bikes.

Traffic Operations. It was difficult to observe trends in traffic operations due to the extremely light volume of traffic. However, some conclusions can be drawn from the limited observation of vehicles and subjective conclusions based on drive-thru techniques.

The preponderance of warning signs in the area, even if the meaning is confused, does attract attention and thus alerts the motorist to an unusual situation ahead. Vehicles decelerate somewhat prior to the intersection but the actual maneuver through the intersection is slightly faster than comfortable. This indicates that unfamiliar motorists do not know exactly what to expect.

The school parking lot presents problems because of approach

locations and limited parking area. Vehicles parked along the western side of the lot must back out of their space. The shoulder of the road is so close that drivers back into the roadway. The east approach not only accommodates school traffic but a rural mailbox cluster is within the intersection approach area and people picking up their mail park in the middle of both the approach and Dover Road.

The most inconspicuous but potential the most hazardous of all movements at this intersection is the southbound straight and left turn movements. The sight distance to the west from either one of these movements is approximately 100 feet. Based on prevailing speeds, this is approximately one half of the distance required. The potential for severe angle and head on accidents due to this condition exists. Accident history would not indicate this problem only because of the low volumes and thus low probabilities of occurrance.

The photo in this report (looking east) shows another problem which would not have been detected if the observer hadn't narrowly escaped collision with the object. A large steel pipe gate for the gravel pit approach is not secured when opened. The wind can evidentially blow the gate open toward Dover Road. When in this position the end of the gate sticks out into the eastbound lane approximately three feet. It is about 2.5 feet above the pavement and is very difficult to see.

Accidents. All but one of the 6 accidents reported at this location were single vehicle accidents. Three of those were at the curve section involving eastbound vehicles. These accidents occurred mainly at night on dry pavement. The most serious operational

deficiencies observed do not correlate with the accident experience. However, there were no accidents in the last 2 years of the reporting period. Apparently the warning signs were installed after the initial accident experience and the devices may have been sufficient to effect a reduction in that type of accident.

SHORT TERM IMPROVEMENTS

The existing intersection geometrics combined with the location of the school presents a double jeopardy situation that is extremely difficult to improve by installation of traffic control devices. A hierarchy of warning signs would have to be determined to properly sign the area. Any change in traffic or operations of the school would make the signing ineffective. Therefore it is recommended that the intersection be reconstructed to better control access and remove potential conflict movements.

The short term improvements sketch indicates the improvements felt necessary. The curve section should be removed and a transition section to connect both legs of Dover Road should be constructed. This would make it a three way stop condition with the approach to the school realigned within the intersection. The west approach to the school should be narrowed as shown to control access and eliminate backing onto the roadway. The mailbox cluster should be relocated away from the intersection area to eliminate potentially dangerous vehicle movements and to reduce conflicts with school approach traffic.

The cost of these improvements is estimated to be approximately $28,000 based on 1985 unit bid contract prices. This project would involve various complexities that would require input from the school

and from residents of the area. Therefore a preliminary design study to coordinate the various interests should be completed prior to the production of design documents and bid letting.

Long term improvements at this intersection cannot be anticipated beyond the short term improvements unless unanticipated development significantly increases volumes on one or both roads.

BENEFITS

If ther is no significance to the past two years of accident history, the greatest percentage accident reduction expected from the improvements would be for single vehicle off road accidents. Since the improvements would basically reduce the potential for more serious angle or head on accidents, it would be difficult to assign a benefit. It is therefore assumed that a reduction in accidents based on the average of the four year period would apply.

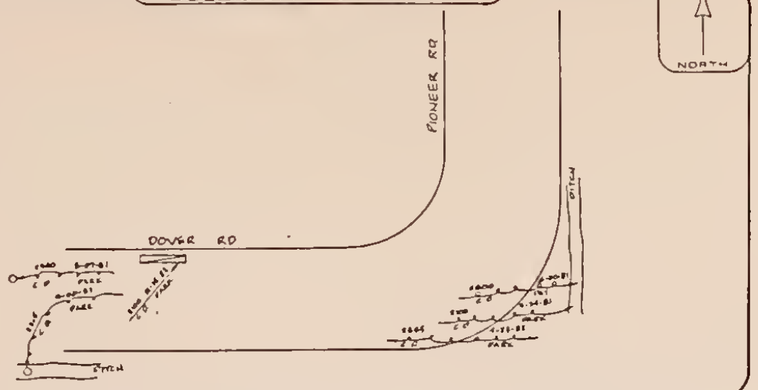
The annual dollar benefit is thus computed to be approximately $8,300. The benefit/cost ratio would therefore be in excess of 1.6.

FUNDING CONSIDERATIONS

These improvements could possibly be completed with the counties annual road maintenance fund or be included in a special program. Because of the high capital cost and relatively small benefit/cost ratio it may be difficult for policy makers to see any immediate needs. However, the potential for a serious accident exists and it may only be a matter of time before it is realized. The priority ranking of this site should remain firm. Attempts to pass over funding of this project for other politically favored projects lower on the list

should be resisted. In addition, the schools parking situation and circulation is critical enough that the county should contact the school with regard to these problems as soon as practical. It may be that the school could submit future budget items to correct on site deficiencies. This would reduce the total amount of work required for the road reconstruction project.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 DATE 7-05-76
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 4
- 1982= 2
- 1983= 0
- 1984= 0

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 0 ANGLE = 0%
- 0 LEFT TURN= 0%
- 0 SIDE SWP.= 0%
- 0 REAR END = 0%
- 5 SINGLE V = 83%
- 1 OTHER = 17%

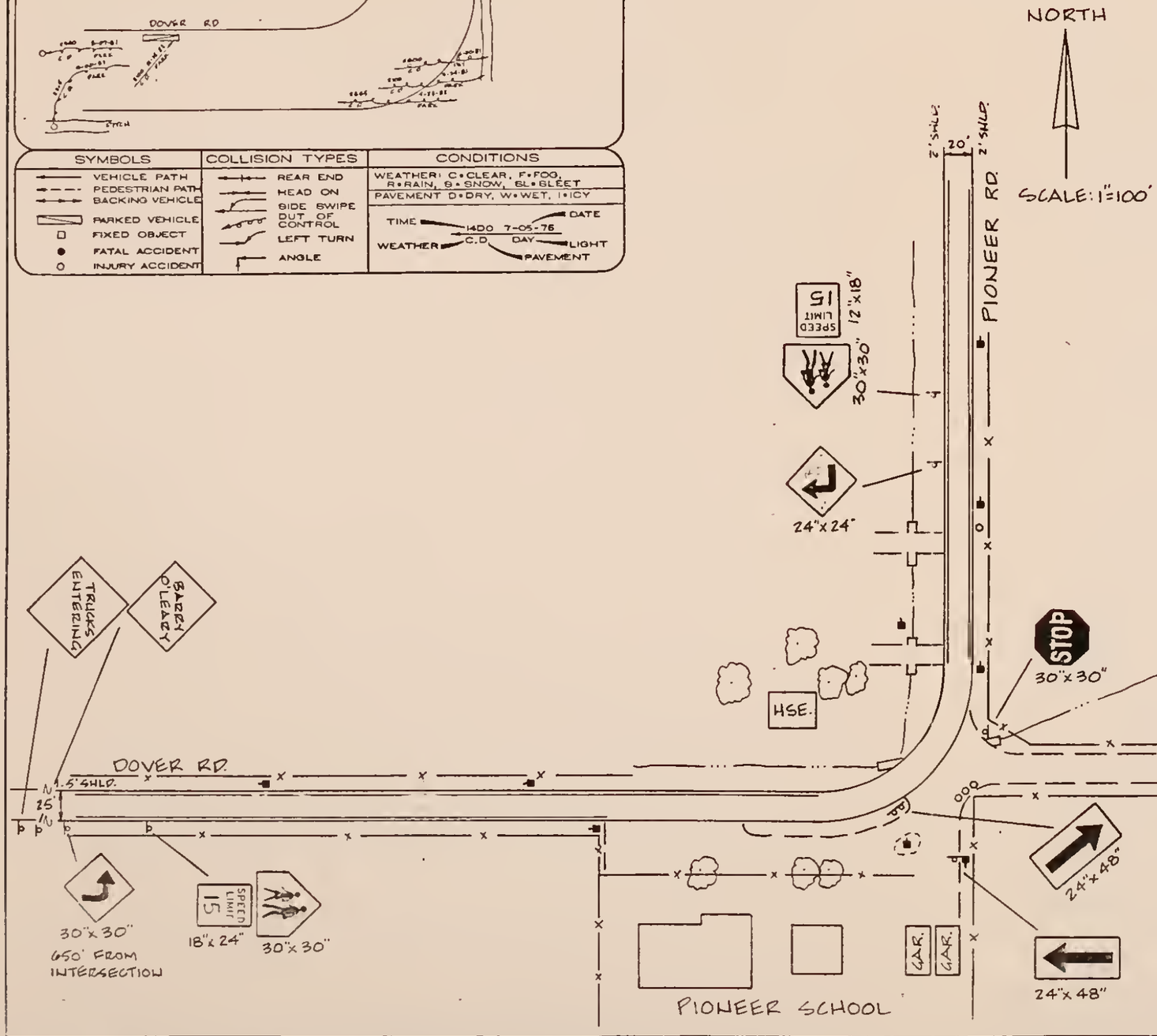
WEATHER CONDITIONS - % OF TOTAL :
- 6 CLEAR = 100%
- 0 RAIN = 0%
- 0 SNOW = 0%
- 0 FOG = 0%

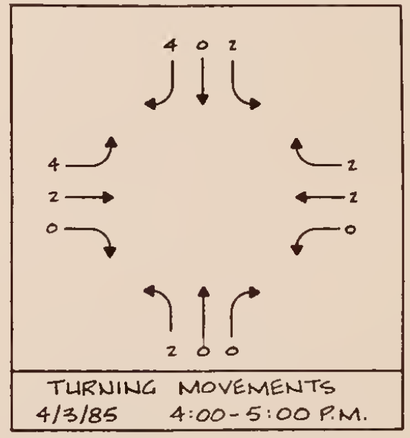
ROAD CONDITIONS - % OF TOTAL :
- 6 DRY = 100%
- 0 WET = 0%
- 0 ICY = 0%

LIGHT CONDITIONS - % OF TOTAL :
- 5 DARK = 83%
- 1 DAY = 17%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 2 INJURY = 33%
- 4 PROP DAM= 67%

ALCOHOL INVOLVED
3 % TOTAL = 50%





TURNING MOVEMENTS
4/3/85 4:00-5:00 P.M.

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N 31st
BILLINGS MT 59107
PH (406) 248-5088

Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: DOVER RD & PIONEER RD EXISTING CONDITIONS

Surveyed By:
Designed By:
Drawn By:
Checked By:
Date:

Rev. Date

Project No

Client No

Sheet No

of

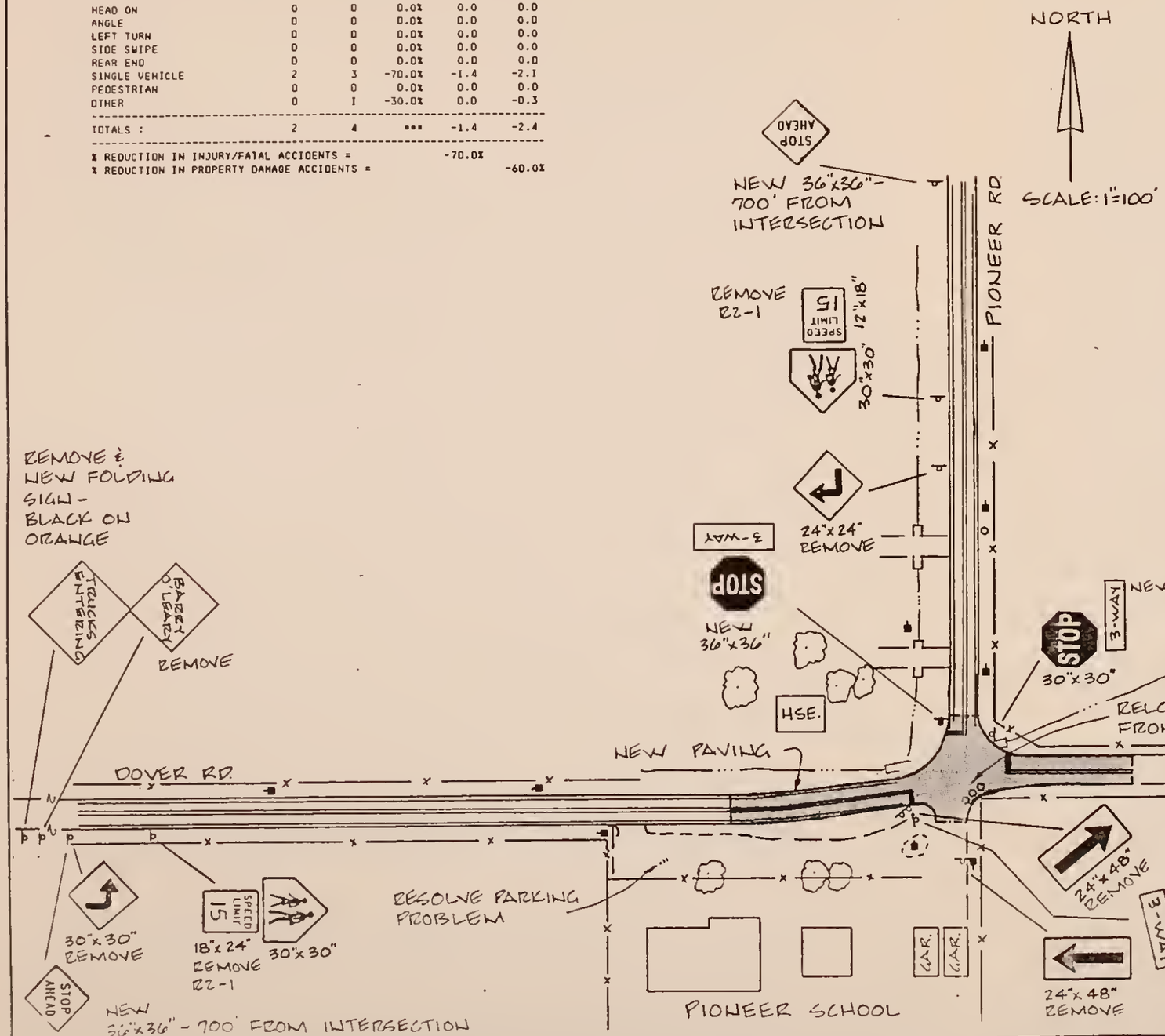
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : DOVER ROAD - PIONEER ROAD

	# ACC. IN PERIOD			CHANGE IN # ACC.	
ACCIDENT TYPE	I/F	PD	EST. % CHANGE	I/F	PD
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	0	0	0.0%	0.0	0.0
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	0	0.0%	0.0	0.0
REAR END	0	0	0.0%	0.0	0.0
SINGLE VEHICLE	2	3	-70.0%	-1.4	-2.1
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	0	1	-30.0%	0.0	-0.3
TOTALS :	2	4	***	-1.4	-2.4

% REDUCTION IN INJURY/FATAL ACCIDENTS = -70.0%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -60.0%



DOVER ROAD - PIONEER ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1.	LS	$500.00	$500.00
2	UNCLASS. EXCAVATION	1200	CY	$3.50	$4,200.00
3	BIT. PLANT MIX PAVING	250	TON	$35.00	$8,750.00
4	AGGREGATE BASE CRSE.	400	CY	$12.00	$4,800.00
5	REMOVE SIGNS	8	Ea	$20.00	$160.00
6	WARNING SIGN ASSEM. 36"	2	Ea	$80.00	$160.00
7	RELOCATE SIGNS	1	Ea	$40.00	$40.00
8	STOP SIGN ASSEMBLY	3	Ea	$125.00	$375.00
9	COLLAPSIBLE WARNING SIGN	1	Ea	$100.00	$100.00
10	4" DIA WOOD SIGN POLES	90	LF	$3.50	$315.00
11	RELOCATE MAILBOXES	1	LS	$200.00	$200.00
12	PAVE. MARKINGS (PAINT)	4	Gal	$25.00	$100.00
13	CONST. TRAFFIC CONTROL	1	LS	$1,500.00	$1,500.00
	SUBTOTAL CONSTRUCTION				$21,200.00
	CONTINGENCY (10%)				$2,120.00
	TOTAL CONSTRUCTION				$23,320.00
	A & E COSTS				$4,664.00
	GRAND TOTAL				$27,984.00

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: DOVER RD & PIONEER ST SHORT TERM IMPROVEMENTS

Designed By:
Drawn By:
Checked By:
Date:

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Sheet No.

#13

HIGHWAY 312 - DOVER ROAD INTERSECTION

PRIORITY NUMBER 13

SITE DESCRIPTION

This intersection is one of six intersections on Highway 312 which is described in the main body of this report. Dover Road is a rural county road which intersect Highway 312 north of Billings. Dover Road is within the Urban Transportation Planning boundaries and is classified as a future minor arterial.

Dover road begins at the intersection with Highway 312 extends to a point approximately 2.5 miles east. Independent Road is the west leg of the intersection in line with Dover Road. It serves residential subdivisions west of the intersection area.

Bitterroot Drive intersects Dover Road approximately 1,000 feet east of the subject intersection.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection has four tangent approaches and the angle of intersection is extremely skewed (approximately 30 degrees). The skew of alignment creates a large area of pavement that is largely uncontrolled as far as vehicle movements are concerned.

The approaches on Highway 312 are tangent and are on an upgrade of approximately 4 % from west to east. The approaches on Dover Road and Independent Road are approximately 1 %.

The Dover Road approach and the Independent Road approaches both include a series of sharp horizontal curves prior to the intersection

(contrary to the sketch). The apparent reason for the unusual alignment i the BBWA Canal which passes through the site.

A BBWA canal crossing of Highway 312 involves a wooden bridge approximately 500 feet northeast of the intersection. This canal crossing is typical of several crossings along Highway 312.

The roadside ditches are fairly flat compared to other areas of Highway 312 where the road grade requires deeper sections.

Traffic Control Devices. Signing at the intersection is minimal. Only the required stop signs for the minor road and hazard markers for the canal crossing exist.

Pavement markings on Highway 312 were freshly painted and conformed to MUTCD standards. Other than fog lines on Dover Road, no other pavement markings appeared to have ever existed on the side road approaches.

Most of the signing at the intersection appears to have been installed within the past two to three years because of the excellent condition they are in. A few older signs are also exists within the intersection area.

Traffic Volumes. Minor road traffic at this intersection is fairly light but Highway 312 traffic is greater than at any point along its length between the Roundup Turnoff and the Huntley approach.

The ADT on Highway 312 is approximately 7,600 while the Dover Road ADT is 700. Independent Road ADT is the least at this site, approximately 400. This intersection is most influenced by commuter peaking characteristics since it is the closest of the Highway 312

intersections to Billings.

Traffic Operations. As is the case for most Highway 312 intersections the operating speed is 55 mph and in excess. The relatively high volume of traffic combined with the site geometrics leaves little room for error in the time required to make decisions regarding direction of travel or reaction to unexpected turning movements. Right turn movements seem to cause the least problems with regard to expectancy. The low volume left turn movements tends to cause the greatest degree of congestion and conflict movement.

Both approaches to Highway 312, although subject to limited sight distance geometrics, provide enough physical clues to warn motorists of am eminent intersection condition.

Accidents. Only eight of the fifteen accidents reported during the four year period can be directly related to the intersection geometrics and operating conditions. Five other accidents may be indirectly related to the intersection because of driver error relative to the exact location of the intersection. The proximity of the Bitterroot Drive intersection approximately 500 feet northeast of the site may also have been an influence on some of the accidents. Two accidents in particular were directly related to that approach.

SHORT TERM IMPROVEMENTS

Violation of expectancy of approach conditions combined with operating speed is clearly a contributing factor to the accident experience. The angle of intersection skew and uncontrolled pavement

area along with the absence of advanced warning and guidance causes the problem with expectancy.

The short term improvements sketch details the recommendations to alleviate these problems. Advanced warning of the intersection from all approach legs is considered necessary and the supplementary plate which identifies the approaching road would improve the expectancy for drivers intent on turning. Minor reconstruction of the approaches would accommodate the minor approach existing movements by providing a near 90 degree angle to Highway 312. It would also provide a marginal separation between the intersections for more precise delineation of conflicting turning vehicle paths. The larger letter street name signs would also provide the necessary confirmation of destination prior to the driver making a commitment to his turn.

The cost of the recommended improvements is estimated to be $16,800 based on 1985 unit bid contract prices.

BENEFITS

By applying advanced warning techniques, realigning the approaches and increasing information to the motorist regarding the exact location of the intersection, the average reduction in accident experience is estimated to be approximately 50 % dependant upon the type of accident.

The annual dollar benefit is thus computed to be approximately $12,400. The benefit/cost ratio would therefore be in excess of 3.5.

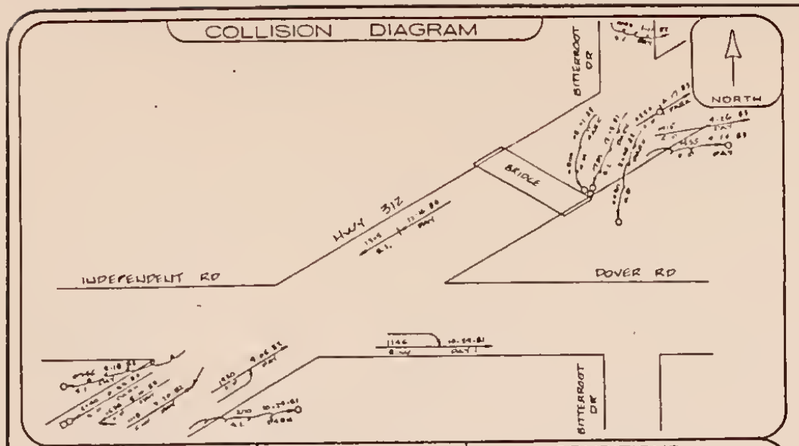
Long term improvements must consider the Urban Transportation Plan in that Bitterroot Drive is classified as an arterial street. The history of Billings Urban Streets which have always neglected

north-south access should not be carried forth into the county where future city streets will be located. Bitterroot Drive should be extended over the BBWA Canal on a continuous alignment and the intersection of Dover Road and Highway terminated. This would involve replatting of some existing streets in the affected subdivision.

FUNDING CONSIDERATIONS

These improvements could possibly be completed with the counties annual road maintenance fund or be included in a special program. Because of the location along Highway 312 a special account to provide special improvements through a general RSID may be necessary. This location is also recommended as a candidate for priority ranking in the MDOH off system safety fund program.

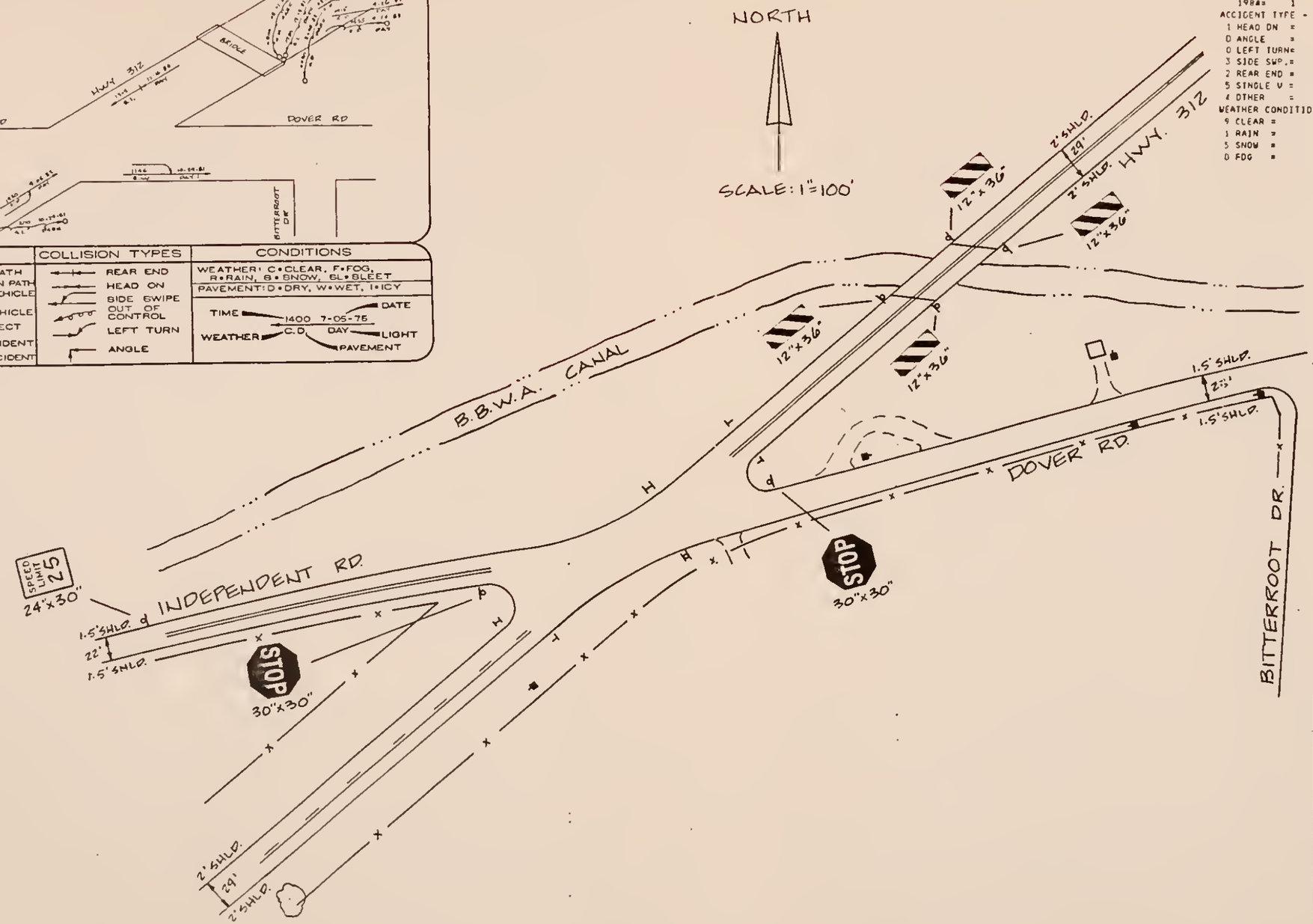
COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 DATE 7-05-75
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

NORTH

SCALE: 1"=100'



STATISTICS

ACCIDENTS / YEAR :
- 1981= 3
- 1982= 3
- 1983= 8
- 1984= 1

ACCIDENT TYPE - % OF TOTAL :
- 1 HEAD ON = 7%
- 0 ANGLE = 0%
- 0 LEFT TURN= 0%
- 3 SIDE SWP.= 20%
- 2 REAR END = 13%
- 5 SINGLE V = 33%
- 4 OTHER = 27%

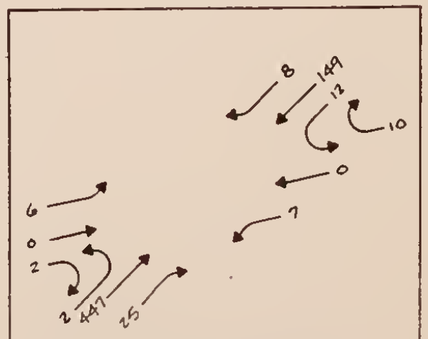
WEATHER CONDITIONS - % OF TOTAL :
- 9 CLEAR = 60%
- 1 RAIN = 7%
- 5 SNOW = 33%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 8 DRY = 53%
- 2 WET = 13%
- 5 ICY = 33%

LIGHT CONDITIONS - % OF TOTAL :
- 6 DARK = 40%
- 9 DAY = 60%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 8 INJURY = 53%
- 7 PROP DAM= 47%

ALCOHOL INVOLVED
4 % TOTAL = 27%



TURNING MOVEMENTS
3/26/85 4:30-5:30 P.M

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN II
404 N. 31st
BILLINGS MT 59101
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Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: HWY 312 & DOVER RD. EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
1. Date
2. Date
3. Date
4. Date

Project No.
Sheet No.
of

SHORT TERM IMPROVEMENTS

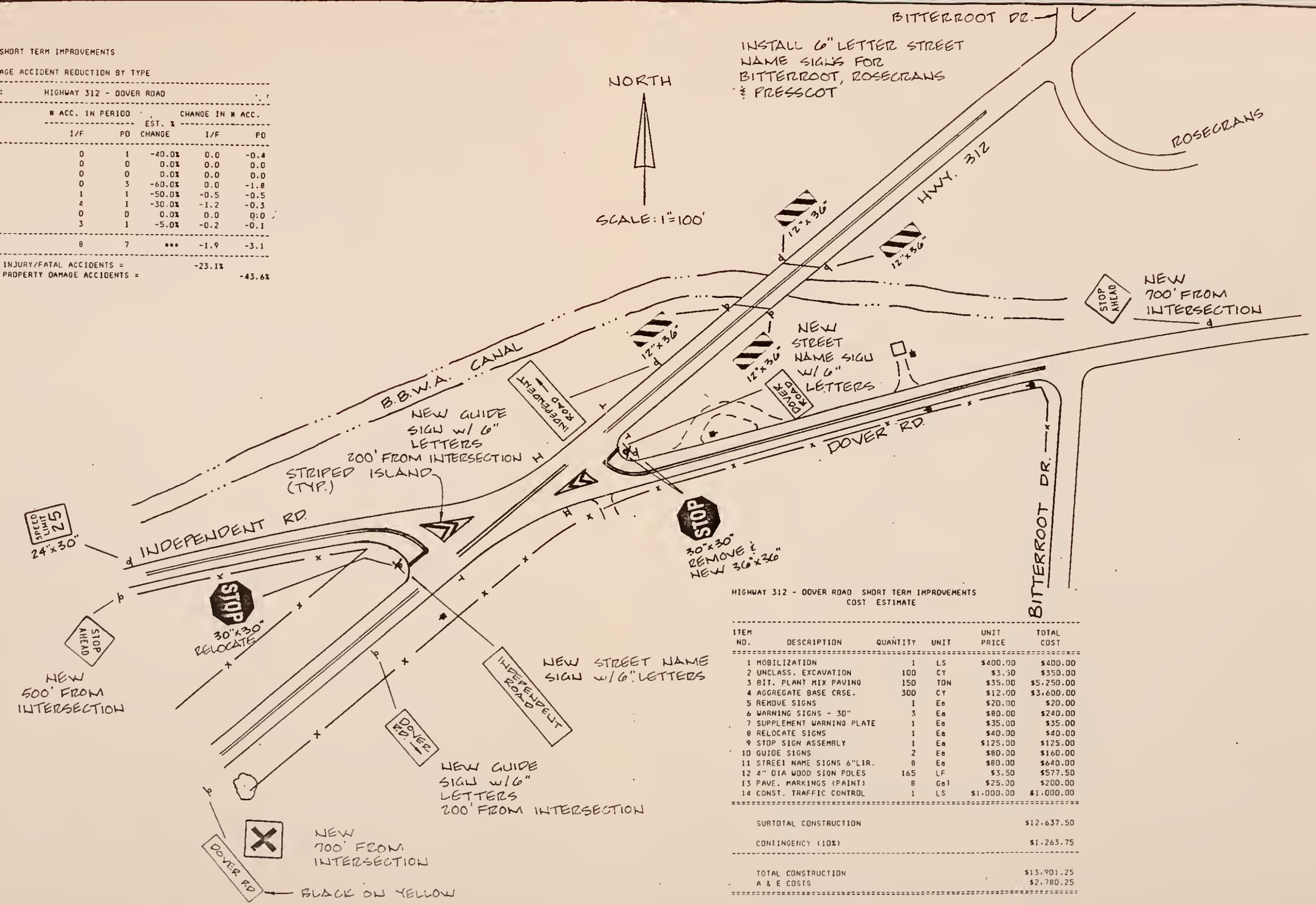
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 312 - DOVER ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	1	-40.0%	0.0	-0.4
ANGLE	0	0	0.0%	0.0	0.0
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	3	-60.0%	0.0	-1.8
REAR END	1	1	-50.0%	-0.5	-0.5
SINGLE VEHICLE	4	1	-30.0%	-1.2	-0.3
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	3	1	-5.0%	-0.2	-0.1
TOTALS :	8	7	***	-1.9	-3.1

% REDUCTION IN INJURY/FATAL ACCIDENTS = -23.1%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -43.6%



HIGHWAY 312 - DOVER ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1	LS	$400.00	$400.00
2	UNCLASS. EXCAVATION	100	CY	$3.50	$350.00
3	BIT. PLANT MIX PAVING	150	TON	$35.00	$5,250.00
4	AGGREGATE BASE CRSE.	300	CY	$12.00	$3,600.00
5	REMOVE SIGNS	1	Ea	$20.00	$20.00
6	WARNING SIGNS - 30"	3	Ea	$80.00	$240.00
7	SUPPLEMENT WARNING PLATE	1	Ea	$35.00	$35.00
8	RELOCATE SIGNS	1	Ea	$40.00	$40.00
9	STOP SIGN ASSEMBLY	1	Ea	$125.00	$125.00
10	GUIDE SIGNS	2	Ea	$80.00	$160.00
11	STREET NAME SIGNS 6"LTR.	8	Ea	$80.00	$640.00
12	4" DIA WOOD SIGN POLES	165	LF	$3.50	$577.50
13	PAVE. MARKINGS (PAINT)	8	Gal	$25.00	$200.00
14	CONST. TRAFFIC CONTROL	1	LS	$1,000.00	$1,000.00
	SUBTOTAL CONSTRUCTION				$12,637.50
	CONTINGENCY (10%)				$1,263.75
	TOTAL CONSTRUCTION				$13,901.25
	A & E COSTS				$2,780.25
	GRAND TOTAL				$16,681.50

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Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: HWY. 312 & DOVER ST. SHORT TERM IMPROVEMENTS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
County No.
Sheet No.

#14

HIGHWAY 312 - McGIRL ROAD INTERSECTION

PRIORITY NUMBER 14

SITE DESCRIPTION

This intersection is one of six intersections on Highway 312 which is described in the main body of this report. McGirl Road is an east-west rural county road which intersect Highway 312 north of Billings. It extends east of Highway 312 approximately 3 miles.

They are two of the roads that comprise the five legged intersection. Cline Road is an east-west gravel road which is the extension of McGirl Road. It extends west of the intersection approximately one mile. Larimer Road is a north-south paved road which extends north of the intersection approximately two miles. All of the minor intersecting roads serve as access to farms and ranchettes. McGirl Road also provides the main access for the Bolero Speedway located approximately 2,000 east of the intersection.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection has five tangent approaches and the skew angles of the intersection is created by Highway 312 which dissects the county roads at a 45 degree angle. The number of approaches and the angle of intersection creates a large area of paving in the middle of the intersection.

All of the approach grades to the intersection are less than 1 %. Roadside ditches, for the most part, are shallow with moderate inslopes.

The roadside environment is replete with houses, sheds, trees poles and irrigation structures. Some sight distance restrictions exist due to the roadside conditions especially on Cline and Larimer Roads.

Traffic Control Devices. Signing at the intersection is minimal. Only the required stop signs for the minor roads exist.

Pavement markings on Highway 312 were freshly painted and conformed to MUTCD standards. No trace of pavement markings were found on the minor approaches.

Traffic Volumes. Minor road traffic at this intersection is very light but Highway 312 traffic is moderately heavy considering that the intersection is approximately 4 miles from the fringe area of Billings.

The ADT on Highway 312 is approximately 4,900. McGirl Road and Larimer Road ADT is approximately 300 and Cline Road is 500. McGirl Road traffic is subjected to the greatest fluctuation in traffic because it serves as the main access to Bolero Speedway. The volumes on McGirl experience the largest peaks after a racing event on the approach direction to Highway 312 when spectators return to Billings and surrounding areas. The peak evening count does not indicate a full representation of turning movements during a normal weekday.

Traffic Operations. As is the case for most Highway 312 intersections the operating speed is 55 mph and in excess. The relatively high volume of traffic combined with the site geometrics

leaves little room for error in the judgement time required to make decisions regarding direction of travel or reaction to unexpected turning movements. Right turn movements seem to cause the least problems with regard to expectancy. The low volume left turn movements tends to cause the greatest degree of congestion and conflict movement.

Because of the number of intersecting roads at this intersection the number of potential conflict points is 48 or 12 more than at a conventional four approach intersection. The low volume of turning traffic reduces the overall probability of accidents even though the potential number of conflict points is high. For this reason only certain operational conflicts were observed.

The most critical movements observed was the left turn from Highway 312 to Larimer Road. There were 12 vehicles making this movement during the peak hour counting period. Vehicles waiting at the stop on Larimer Road with the intent to turn left or access McGirl Road observe the approaching vehicles signal and instinctively assume that it will turn onto Cline. Other similar conditions would exist at this intersection at various periods of traffic loadings.

In addition to misinterpretation of driver's intent, the left turn movement from Highway 312 to Larimer is performed at near highway speeds and involves traveling in the wrong lane of Highway 312 for a short distance. The approach speed for that maneuver is a hidden hazard since it feels comfortable to the driver but he is unaware that the house and trees limit sight distance far below required stopping sight distance.

The minor road approaches all share a common problem related to

horizon interference. The flat topography draws drivers attention toward the horizon and there is a tendency to drive beyond normal focus points. The worst example is the McGirl Road approach. Since Cline Road has an upgrade in the horizon, it appears that McGirl Road continues straight ahead without interruptions for over a mile while no other physical clues to the existence of the intersection are apparent.

Accidents. There were 12 accidents total during the four year reporting period. The majority of accidents were split equally between angle, rear end and single vehicle type accidents. At least 75 % of the accidents were related to the low level of expectancy with the McGirl Road approach being responsible for 50 % of those. Pavement conditions were dry for the majority of accidents while most of them occurred during hours of darkness.

SHORT TERM IMPROVEMENTS

Unexpectancy of conditions for approaching traffic is clearly a contributing factor to the accident experience. The angle of intersection skews and uncontrolled pavement area along with the absence of advanced warning and guidance causes the relative problem with expectancy.

The short term improvements sketch details the recommendations to alleviate these problems. Advanced warning of the intersection from all approach legs is considered necessary and the supplementary plate which identifies the approaching road would improve the expectancy for drivers intent on turning. Advanced warning of the stop conditions

on the minor approaches will provide the necessary information that the topographic conditions fail to provide.

Reconstruction of the approaches would accommodate the minor approach traffic's existing movements by providing an area to stop at a near 90 degree angle to Highway 312 traffic. It would also provide a marginal separation between the intersections for more precise delineation of conflicting turning vehicle paths.

The larger letter street name signs would also provide the necessary confirmation of destination prior to the driver making a commitment to his turn. Since the Bolero Speedway is a major generator of traffic at this intersection, a guide sign is considered necessary. This sign would have added value since a large segment of the speedway traffic is probably unfamiliar with the area.

The cost of the recommended improvements is estimated to be $14,600 based on 1985 unit bid contract prices. Included in the total cost is Engineering and administrative fees.

BENEFITS

By applying advanced warning techniques, realigning the approach conditions and increasing information to the motorist regarding the exact location of the intersection, the average reduction in accident experience is estimated to be approximately 50 % dependant upon the type of accident. Angle accidents would experience the greatest reduction at 80 %.

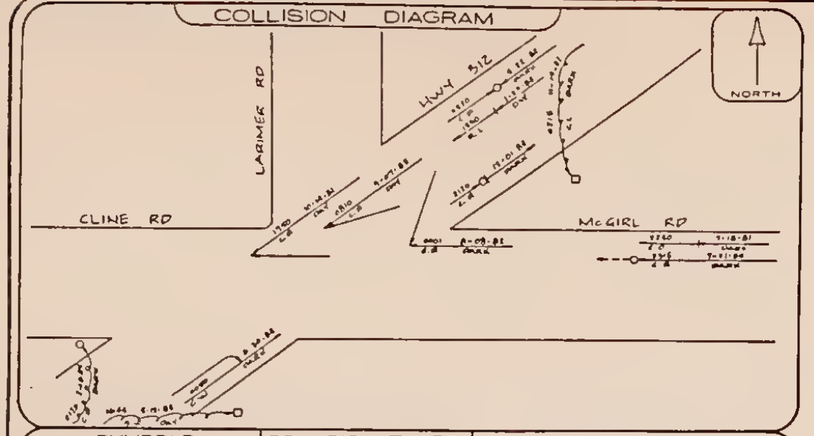
The annual dollar benefit is thus computed to be approximately $8,300. The benefit/cost ratio would therefore be in excess of 2.5.

LONG TERM IMPROVEMENTS

Future improvements should consider separation of the McGirl-Larimer intersection and the Cline Road intersection by a minimum of 500 feet. This would reduce the total number of conflict points from 48 at one location to a total of 38 at two locations. Any significant increases in minor road traffic or increases in turning movements have the potential to create serious operational and safety problems at this intersection. The county planning agency should be made aware of potential impacts that traffic generating developments may have on this intersection so that they can evaluate any developments that may be proposed in the future.

FUNDING CONSIDERATIONS

These improvements could possibly be completed with the counties annual road maintenance fund or be included in a special program. Because of the location along Highway 312 a special account to provide special improvements through a general RSID may be necessary. This location is also recommended as a candidate for priority ranking in the MDOH off system safety fund program.



STATISTICS

ACCIDENTS / YEAR :
- 1981= 2
- 1982= 3
- 1983= 5
- 1984= 2

ACCIDENT TYPE - % OF TOTAL :
- 1 HEAD ON = 8%
- 3 ANGLE = 25%
- 0 LEFT TURN= 0%
- 1 SIDE SWP.= 8%
- 3 REAR END = 25%
- 1 SINGLE V = 8%
- 3 OTHER = 25%

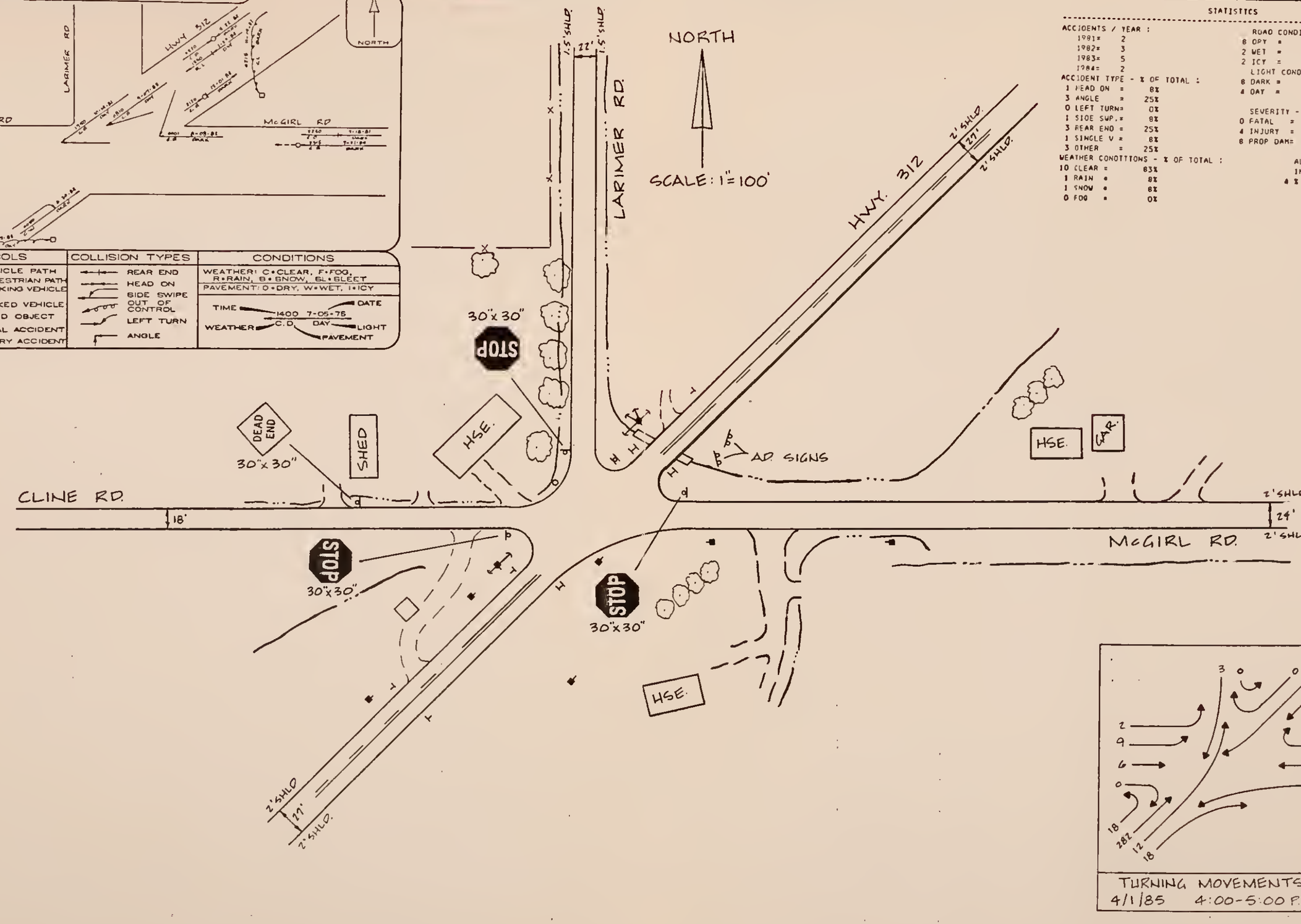
WEATHER CONDITIONS - % OF TOTAL :
- 10 CLEAR = 83%
- 1 RAIN = 8%
- 1 SNOW = 8%
- 0 FOG = 0%

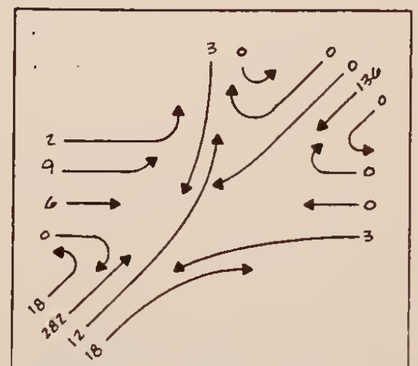
ROAD CONDITIONS - % OF TOTAL :
- 8 DRY = 67%
- 2 WET = 17%
- 2 ICY = 17%

LIGHT CONDITIONS - % OF TOTAL :
- 8 DARK = 67%
- 4 DAY = 33%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 4 INJURY = 33%
- 8 PROP DAM= 67%

ALCOHOL INVOLVED
4 % TOTAL = 33%





TURNING MOVEMENTS
4/1/85 4:00-5:00 P.M.

MARVIN & ASSOCIATES — Traffic Transportation & Civil Engineers	SUITE 304 TRANSWESTERN II, 404 N. 31st, BILLINGS MT 59101, Ph (406) 248-6088	Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS	Sheet Title: HWY. 312 & McGIRL RD. EXISTING CONDITIONS	Surveyed By / Designed By / Drawn By / Checked By / Date	Revisions: No. Date; Project No.; Sheet No.

SHORT TERM IMPROVEMENTS

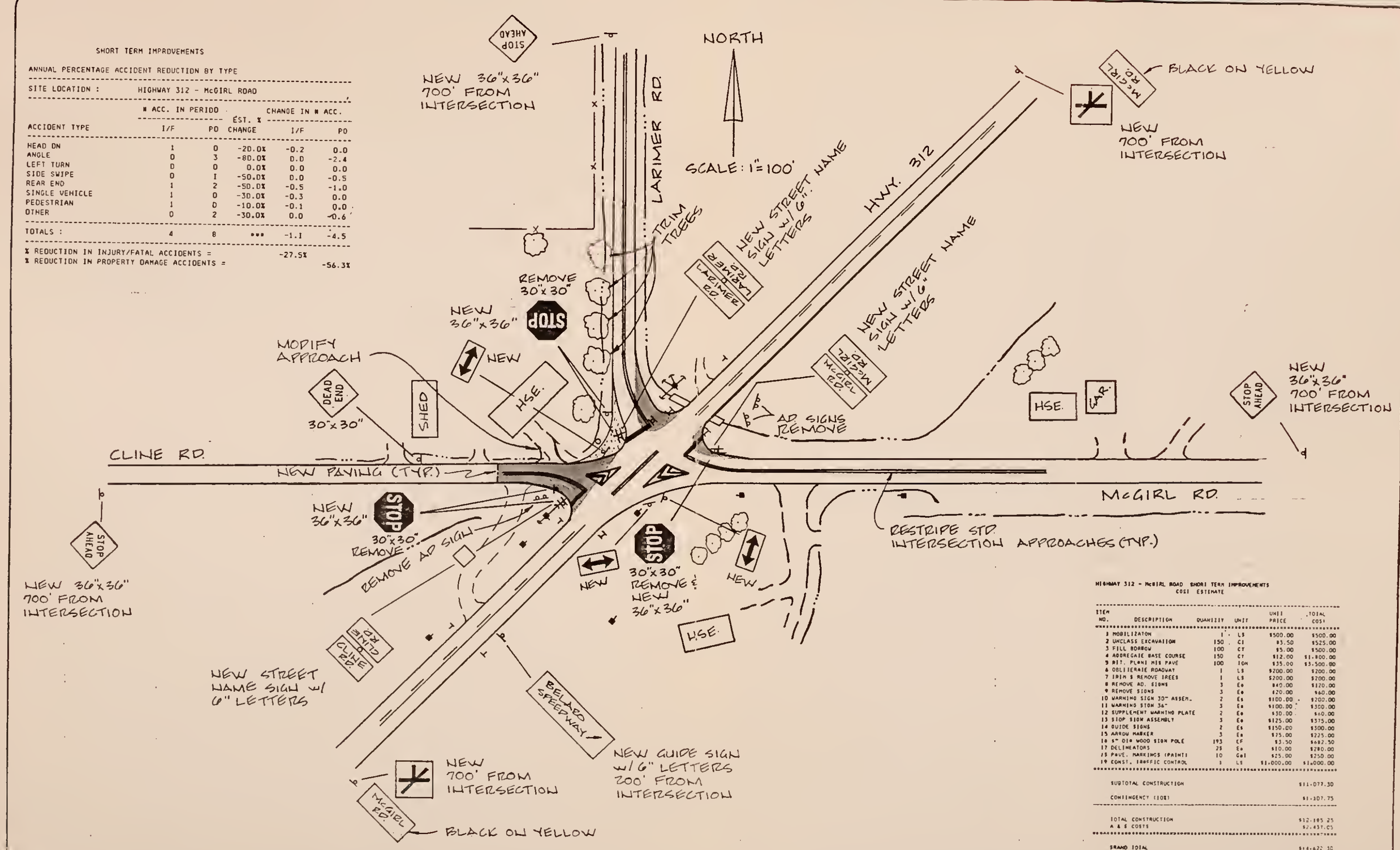
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 312 - McGIRL ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	1	0	-20.0%	-0.2	0.0
ANGLE	0	3	-80.0%	0.0	-2.4
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	1	-50.0%	0.0	-0.5
REAR END	1	2	-50.0%	-0.5	-1.0
SINGLE VEHICLE	1	0	-30.0%	-0.3	0.0
PEDESTRIAN	1	0	-10.0%	-0.1	0.0
OTHER	0	2	-30.0%	0.0	-0.6
TOTALS :	4	8	***	-1.1	-4.5

% REDUCTION IN INJURY/FATAL ACCIDENTS = -27.5%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -56.3%



HIGHWAY 312 - McGIRL ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATON	1	LS	$500.00	$500.00
2	UNCLASS EXCAVATION	150	CY	$3.50	$525.00
3	FILL BORROW	100	CY	$5.00	$500.00
4	AGGREGATE BASE COURSE	150	CY	$12.00	$1,800.00
5	BIT. PLANT MIX PAVE	100	TON	$35.00	$3,500.00
6	OBLITERATE ROADWAY	1	LS	$200.00	$200.00
7	TRIM & REMOVE TREES	1	LS	$200.00	$200.00
8	REMOVE AD. SIGNS	3	Ea	$40.00	$120.00
9	REMOVE SIGNS	3	Ea	$20.00	$60.00
10	WARNING SIGN 30" ASSEM.	2	Ea	$100.00	$200.00
11	WARNING SIGN 36"	3	Ea	$100.00	$300.00
12	SUPPLEMENT WARNING PLATE	2	Ea	$30.00	$60.00
13	STOP SIGN ASSEMBLY	3	Ea	$125.00	$375.00
14	GUIDE SIGNS	2	Ea	$150.00	$300.00
15	ARROW MARKER	3	Ea	$75.00	$225.00
16	6" DIA WOOD SIGN POLE	193	CF	$3.50	$682.50
17	DELINEATORS	28	Ea	$10.00	$280.00
18	PAVE. MARKINGS (PAINT)	10	Gal	$25.00	$250.00
19	CONST. TRAFFIC CONTROL	1	LS	$1,000.00	$1,000.00
	SUBTOTAL CONSTRUCTION				$11,077.50
	CONTINGENCY (10%)				$1,107.75
	TOTAL CONSTRUCTION				$12,185.25
	A & E COSTS				$2,437.05
	GRAND TOTAL				$14,622.30

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN
404 N. 31st
BILLINGS MT. 59101
PH. (406) 248-5065

Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: HWY. 312 & McGIRL RD. SHORT TERM IMPROVEMENTS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Sheet No.
Sheet No. of

#15

56TH STREET WEST - DANFORD ROAD INTERSECTION

PRIORITY NUMBER 15

SITE DESCRIPTION

Fifty Sixth Street West is north-south Principal Arterial Street which extends from a point near the South Frontage Road south of Interstate 90 to an intersection with Grand Avenue west of Billings.

Danford Road is an east-west rural route which has continuity from a point four miles west of the intersection site to a point one mile east of the site. It serves rural traffic west of 56th Street W. and accesses residential subdivisions east of the of intersection.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. The horizontal geometrics of this site are quite unique. The intersection is bisected by the BBWA Canal with a unusual shaped bridge serving as the center of the intersection.

The north, south and west legs of the intersection all have tangent approach alignments. The east leg has reverse curves on its approach to the intersection. The curves were apparently constructed to avoid a skewed crossing of the canal.

The intersection lies on a side hill with the general slope of the land raising to the northwest. Approach grade on the approaches legs range between 3 and 5 %. Crest vertical curves affect sight distance on both the southbound and eastbound approaches.

Roadside features consist of poles, fences and trees. No

buildings are in close enough proximity to affect the operation of the intersection. Roadside ditches, for the most part, are shallow.

Traffic Control Devices. This intersection, by its unorthodox appearance, was obviously of concern to the county in past years because there was a wide variety of warning and regulatory signs which were installed at various points in time. There is advanced warning of the intersection from all approaches; hazard markers on every object within range of the shoulder; warning arrows and even an unconventional warning sign regarding slow vehicles entering.

Several problems with the signing were noted :

1. Some of the signs have lost their reflectivity. There are many signs that depend on there location with respect to other signs and when one or two of them are not reflective at night misinformation regarding the conditions is given.

2. The double headed arrow for the northbound approach is a misapplication of that sign.

3. For the Danford Road approaches, the arrows and hazard markers distract from critical information supplied by the stop signs.

4. As is the case with most of the study sites, the advanced warning signs are position too close to the intersection.

5. The preponderance of signs is overwhelming especially at night. Guide signing which would improve expectancy in this case is missing.

The only pavement marking noted in the area is shown on the existing condition sketch. The dashed lines on 56th Street W. are not standard intersection stripes. In this case, markings and roadside

delineation would go a long way toward improving driver expectancy.

Traffic Volumes. Average Daily Traffic on all legs is fairly equal. The average ADT is approximately 500. All turning movements were represented during the one hour counting period. No real predominant directional movements were noted.

Traffic Operations. Traffic volumes were too low to detect trends in operational problems. Operational analysis is based on a subjective evaluation of the site from trial drive-thru observations both during the day and at night.

Most of the operational deficiencies are related to the traffic control devices which is detailed above. The horizon interference with distance perception is evident on all of the approaches. The existence of the intersection and the location of the approaches is very difficult to perceive. Unfamiliar motorists undoubtedly reduce speed when the signing is noticed and the physical features of the roadway are not apparent. Drivers familiar with the intersection probably approach the intersection with practiced caution.

Accidents. There were six accidents in the four year reporting period. It is somewhat surprising, at first, to see that none of the accidents were single vehicle off-road type accidents since that is a common rural accident. However, this situation correlates with observed conditions and operations. This is apparently a location that appears to be so dangerous that motorists exercise added caution.

Four of the accidents were angle accidents. Sight distance and angle of approach deficiencies were related to those accidents.

The majority of accidents occurred on dry pavement during daylight hours. The fact that nighttime accidents are low is also consistent with the observation that the perception of abundant signing causes added caution, since the signing is more obvious at night.

SHORT TERM IMPROVEMENTS

The short term improvements sketch details the recommended improvements at this site. They are relatively small items consisting mostly of new traffic control devices.

The main purpose of these recommendations is to increase the degree of information available to the driver which will require less decision time. The new and relocated advanced warning signs will also aid in providing timely information.

Channelization of the westbound approach with pavement markings will provide positive guidance to the motorist with regard to required positioning at the stop. This along with tree trimming and mailbox relocations should improve the approach site distance.

Restriping the entire intersection area will greatly reinforce motorists expectations.

The improvements could be installed by County maintenance forces which would reduce estimated costs. Based on 1985 unit bid contract prices the cost of these improvements is estimated to be $2,800.00.

LONG TERM IMPROVEMENTS

It is assumed that volumes will not reach a critical stage within the next 10 years. At some future time when volumes stress the

safety and capacity of this intersection, a reconstruction project which would require a new Canal crossing structure would be recommended. The reconstructed alignment should move the intersection north of its present location so that Danford would cross the canal at a slight skew angle approximately 200 feet east of the new intersection area. It would also require reconstruction of the crest vertical curve on 56th Street W. to gain required intersection sight distance.

The land required for this recommendation is currently vacant. The county should attempt to reserve the option for a road easement in that area.

If the existing structure is ever replaced by bridge replacement funds, relocation of the intersection should be considered a number one priority.

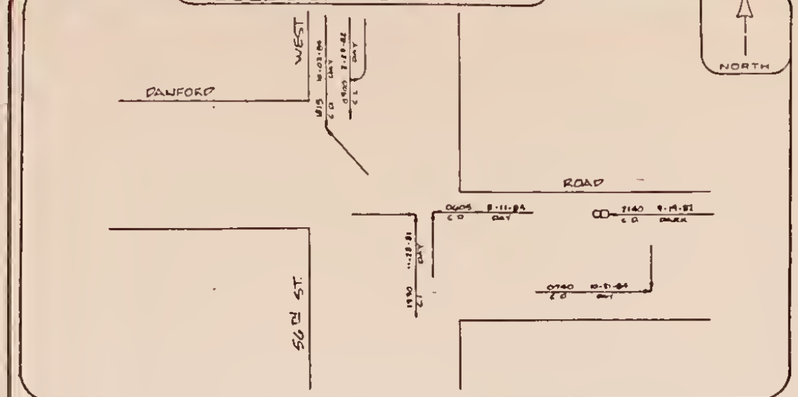
BENEFITS

By improving driver expectancy through positive guidance and advanced information and by improving sight distance, the accident rate is expected to be reduced by up to 80% for angle accidents and side swipe accidents would be improved by approximately 50%. The net benefit according to stated methods would be approximately $ 1,600 annually. The low accident rate almost matches the low cost of improvements and therefore the benefit/cost is slightly above 1.5 which is fairly low for improvements involving only traffic control devices.

FUNDING CONSIDERATIONS

It is recommended that this project be completed by either a special annual program or by the existing county road fund. Regardless of timing for the whole improvement project, some of the traffic control device deficiencies should be corrected as soon as possible using normal maintenance funds if possible.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME — HDD 7-05-75 — DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER — C.D — DAY — LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 1
- 1982= 2
- 1983= 1
- 1984= 2

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 4 ANGLE = 67%
- 0 LEFT TURN= 0%
- 1 SIDE SWP.= 17%
- 0 REAR END = 0%
- 0 SINGLE V = 0%
- 1 OTHER = 17%

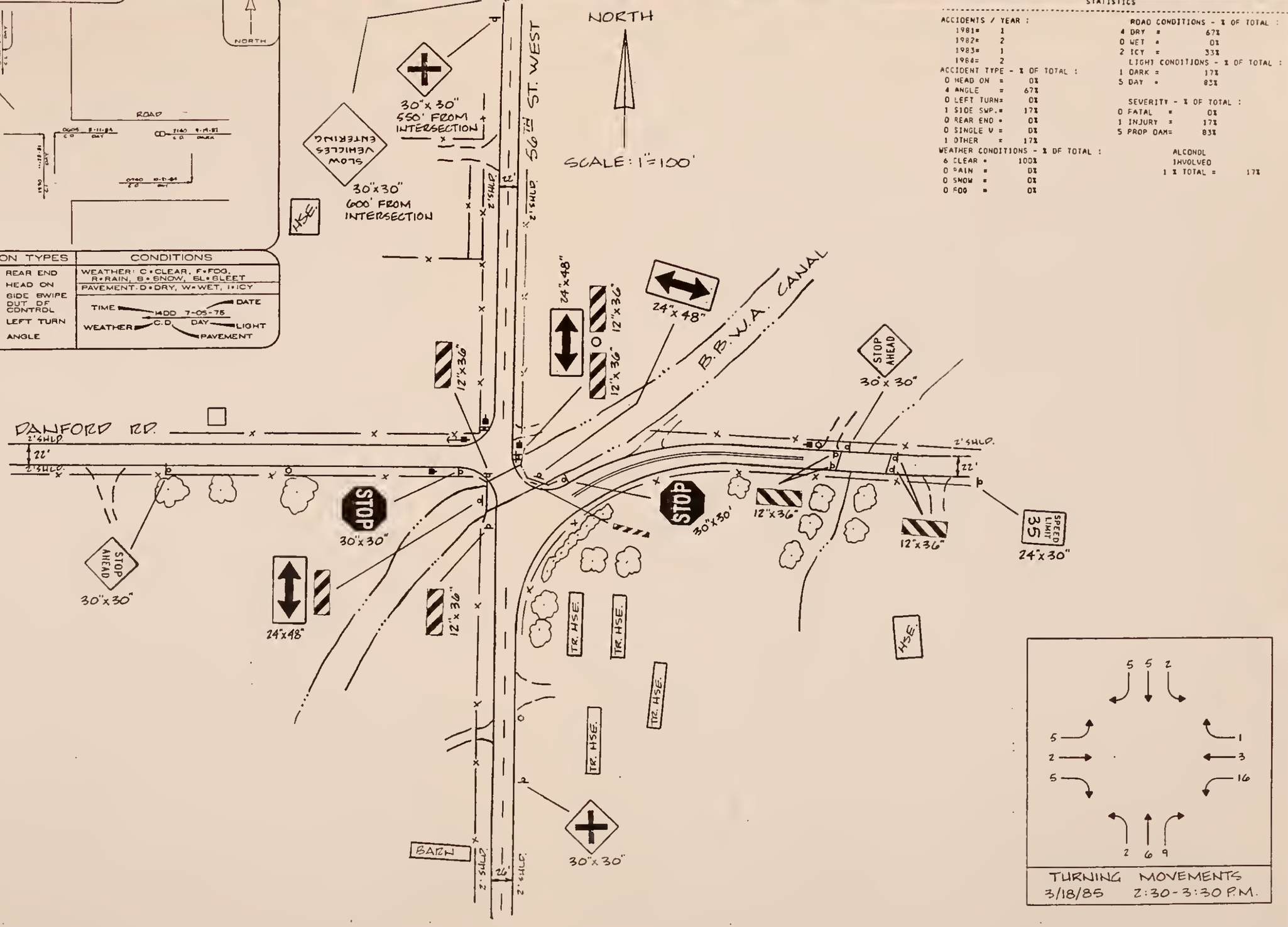
WEATHER CONDITIONS - % OF TOTAL :
- 6 CLEAR = 100%
- 0 RAIN = 0%
- 0 SNOW = 0%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 4 DRY = 67%
- 0 WET = 0%
- 2 ICY = 33%

LIGHT CONDITIONS - % OF TOTAL :
- 1 DARK = 17%
- 5 DAY = 83%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 1 INJURY = 17%
- 5 PROP DAM= 83%

ALCOHOL INVOLVED
1 % TOTAL = 17%



TURNING MOVEMENTS
3/18/85 2:30-3:30 P.M.

MARVIN & ASSOCIATES — Traffic Transportation & Civil Engineers — SUITE 304 TRANSWESTERN I, 404 N. 31st, BILLINGS MT 59107, Ph. (406) 248-5085	Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS	Sheet Title: 56TH ST. W & DANFORD DR. EXISTING CONDITIONS	Surveyed By / Designed By / Drawn By / Checked By / Date	Project No. / Sheet No. / of

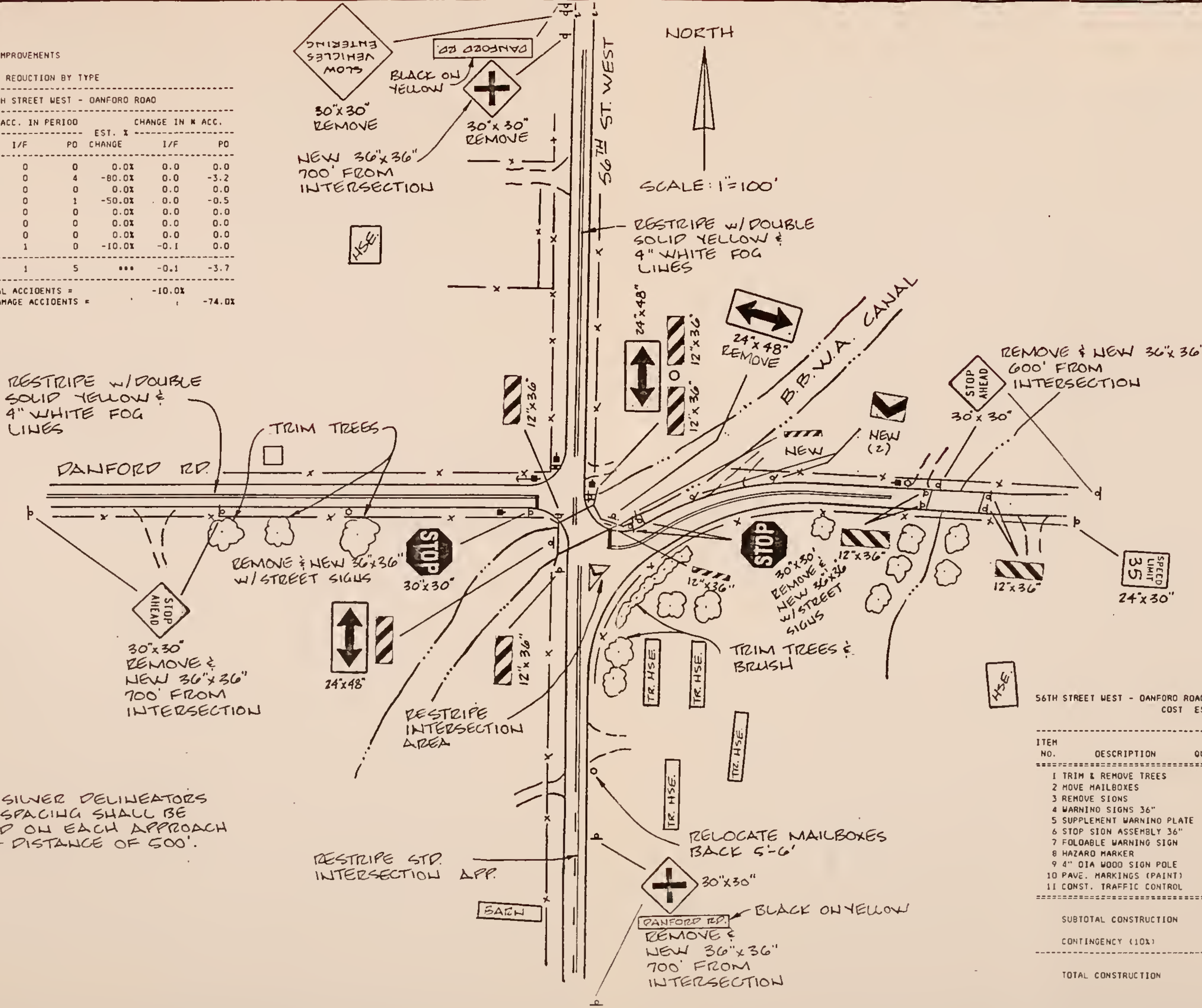
SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : 56TH STREET WEST - DANFORD ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	0	4	-80.0%	0.0	-3.2
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	1	-50.0%	0.0	-0.5
REAR END	0	0	0.0%	0.0	0.0
SINGLE VEHICLE	0	0	0.0%	0.0	0.0
PEDESTRIAN	0	0	0.0%	0.0	0.0
OTHER	1	0	-10.0%	-0.1	0.0
TOTALS :	1	5	***	-0.1	-3.7

% REDUCTION IN INJURY/FATAL ACCIDENTS = -10.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -74.0%



NOTE:
NEW SILVER DELINEATORS @ 100' SPACING SHALL BE PLACED ON EACH APPROACH FOR A DISTANCE OF 500'.

56TH STREET WEST - DANFORD ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	TRIM & REMOVE TREES	1	LS	$500.00	$500.00
2	MOVE MAILBOXES	1	LS	$100.00	$100.00
3	REMOVE SIGNS	8	Ea	$20.00	$160.00
4	WARNING SIGNS 36"	4	Ea	$80.00	$320.00
5	SUPPLEMENT WARNING PLATE	2	Ea	$40.00	$80.00
6	STOP SIGN ASSEMBLY 36"	2	Ea	$150.00	$300.00
7	FOLDABLE WARNING SIGN	1	LS	$100.00	$100.00
8	HAZARD MARKER	1	Ea	$30.00	$30.00
9	4" DIA WOOD SIGN POLE	105	LF	$3.50	$367.50
10	PAVE. MARKINGS (PAINT)	18	Gal	$25.00	$450.00
11	CONST. TRAFFIC CONTROL	1	LS	$100.00	$100.00
	SUBTOTAL CONSTRUCTION				$2,507.50
	CONTINGENCY (10%)				$250.75
	TOTAL CONSTRUCTION				$2,758.25

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I
404 N. 31st
BILLINGS MT 59101
Ph. (406) 248-5080

Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: 56TH ST. WEST & DANFORD RD. SHORT TERM IMPROVEMENTS

#16

HIGHWAY 312 - BARRY ROAD INTERSECTION

PRIORITY NUMBER 16

SITE DESCRIPTION

This intersection is one of six intersections on Highway 312 which is described in the main body of this report. Barry Road is a north-south rural county road which intersect Highway 312 north of Billings. Barry Road is one of three roads which provides access to a large residential subdivision north of Highway 312 between Dover Road and the BBWA Canal just east of the site. The intersection is located approximately 4,000 feet east of Dover Road, another study site

Wagon Wheel Road, just west of Barry Road is actually the main access to this subdivision. Some of the accident cluster has been also identified with Wagon Wheel Road.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection is a 30 degrees skewed "T" intersection. Barry Road is a gravel surfaced road which has a 3 % downgrade toward Highway 312. Highway 312 has a variable downgrade approach ranging between 2 & 4 % sloping toward the east. Just prior to the Wagon Wheel approach a crest vertical curve is present which barely meets intersection sight distance requirements. Approximately 500 feet east of the intersection there is a bridge over the BBWA Canal.

The roadside environment has begun to change within the past three years. A residential dwelling has been constructed in the northwest quadrant of the intersection and a building which is

currently being used to rent video tapes is located southeast of the intersection. Roadside ditches are fairly shallow with 4:1 inslopes. Other than undulations in the vertical profile of the road and mid summer vegetation growth the intersection area visibility is good.

Traffic Control Devices. Signing at the intersection is minimal. Only the required stop sign for the minor road and hazard markers for the canal crossing exist.

Pavement markings on Highway 312 were freshly painted and conformed to MUTCD standards.

Traffic Volumes. Minor road traffic at this intersection is fairly light but Highway 312 traffic is heavy since it is within one mile of the fringe area of Billings.

The ADT on Highway 312 is approximately 7,000 while Barry Road ADT is 400. Wagon Wheel Road ADT is greater than Barry Road at 600. The predominant movement at the Barry Road intersection is the eastbound left turn movement as would be expected during the peak evening hour with commuter type traffic.

Traffic Operations. As is the case for most Highway 312 intersections the operating speed is 55 mph and in excess. The relatively high volume of traffic combined with the site geometrics leaves little room for error or the time required to make decisions regarding direction of travel or reaction to unexpected turning movements. The left turn movements at both Wagon Wheel Road and Barry Road tends to cause the greatest degree of congestion and conflict

movement.

Accidents. There were nine accidents within the vicinity of the Barry Road intersection during the four year reporting period. Only three of those accident could be directly related to the geometrics, signing or operational observations. Seven of those accidents have occurred in the past two years and the majority of those in the last year (1984). It appears that the accident rate is on the increase. It is probably due to increased occupancy of the residential subdivisions to the north of Highway 312. Most of the operational problems with this intersection correlate quite closely to the accident experience in the past year. This indicates that a change in accident experience is in a transitional state as population growth occurs north of the intersection.

SHORT TERM IMPROVEMENTS

The unexpected nature of the approach combined with operating speed is clearly a contributing factor to the accident experience. The angle of intersection skew and uncontrolled pavement area along with the absence of advanced warning and guidance causes the relative problem with expectancy and the reaction or over reaction to the conditions encountered.

The short term improvements sketch details the recommendations to alleviate these problems. Advanced warning of the intersection from all approach legs is considered necessary and the supplementary plate which identifies the approaching road would improve the expectancy for drivers intent on turning.

Paving of the approach aprons would decrease the gap time required for exit onto the minor approaches from Highway 312 and thus would minimize conflict exposure time. The business establishment south of the intersection had opened during the course of this study. To avoid potential problems with its approach to Highway 312, it should be moved to align with the Barry Road approach.

The larger letter street name signs would also provide the necessary confirmation of destination prior to the driver making a commitment to his turn.

The cost of the recommended improvements is estimated to be $7,800 based on 1985 unit bid contract prices.

BENEFITS

By applying advanced warning techniques, restructuring the approach conditions and increasing information to the motorist regarding the exact location of the intersection, the average reduction in accident experience is estimated to be approximately 50 % dependant upon the type of accident.

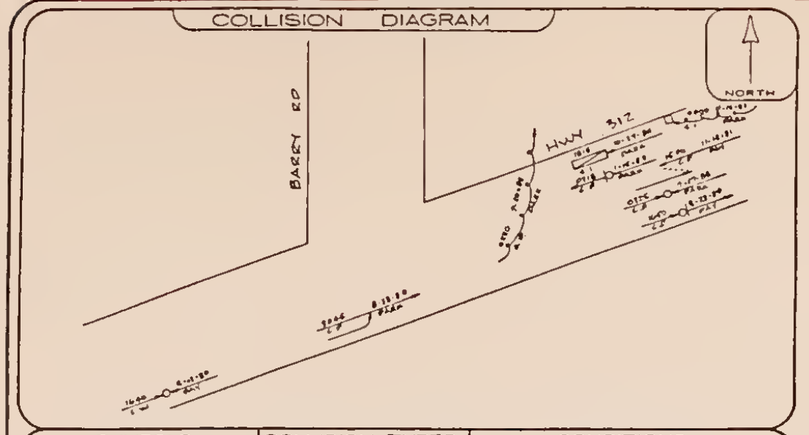
The annual dollar benefit is thus computed to be approximately $7,600. The benefit/cost ratio would therefore be in excess of 3.0.

Long term improvements must consider the future growth of subdivision development north of Highway 312. Reconstruction of the major route should be designed to accommodate major access approaches by either including auxiliary turn lanes or by consolidating approaches and using frontage roads.

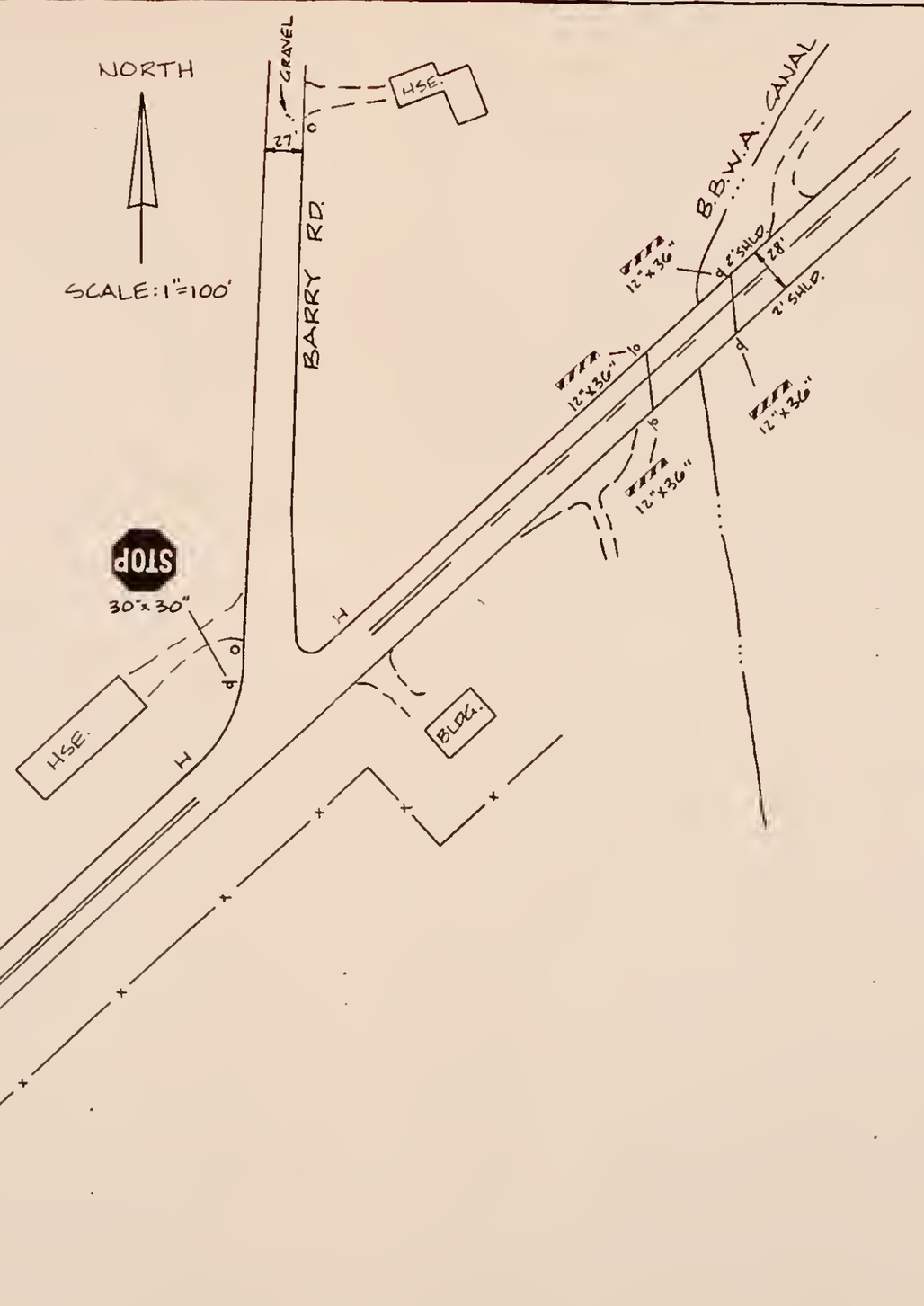
FUNDING CONSIDERATIONS

These improvements could possibly be completed with the counties annual road maintenance fund or be included in a special program. Because of the location along Highway 312 and since the developments north of the highway have occurred in the recent past, a special account to provide special improvements through a general RSID may be necessary. This location is also recommended as a candidate for priority ranking in the MDOH off system safety fund program.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 DATE 7-05-75
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		



STATISTICS

ACCIDENTS / YEAR :
- 1981= 1
- 1982= 1
- 1983= 3
- 1984= 4

ACCIDENT TYPE - % OF TOTAL :
- 2 HEAD ON = 22%
- 0 ANGLE = 0%
- 0 LEFT TURN= 0%
- 1 SIDE SWP.= 11%
- 2 REAR END = 22%
- 1 SINGLE V = 11%
- 3 OTHER = 33%

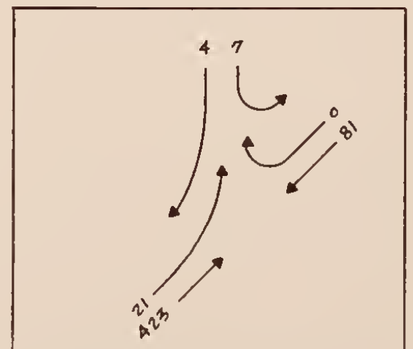
WEATHER CONDITIONS - % OF TOTAL :
- 7 CLEAR = 78%
- 0 RAIN = 0%
- 2 SNOW = 22%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 6 DRY = 67%
- 1 WET = 11%
- 2 ICY = 22%

LIGHT CONDITIONS - % OF TOTAL :
- 6 DARK = 67%
- 3 DAY = 33%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 4 INJURY = 44%
- 5 PROP DAM= 56%

ALCOHOL INVOLVED
2 % TOTAL = 22%



TURNING MOVEMENTS
3/28/85 4:30-5:30 P.M.

MARVIN & ASSOCIATES
SUITE 304 TRANSWESTERN I
404 N. 31ST
BILLINGS MT 59107
Traffic Transportation & Civil Engineers Ph (406) 248-5066

Project: TRAFFIC SAFETY STUDY — YELLOWSTONE COUNTY ROADS

Sheet Title: HWY. 312 & BARRY RD. EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Comm No.
Sheet No.
of

SHORT TERM IMPROVEMENTS

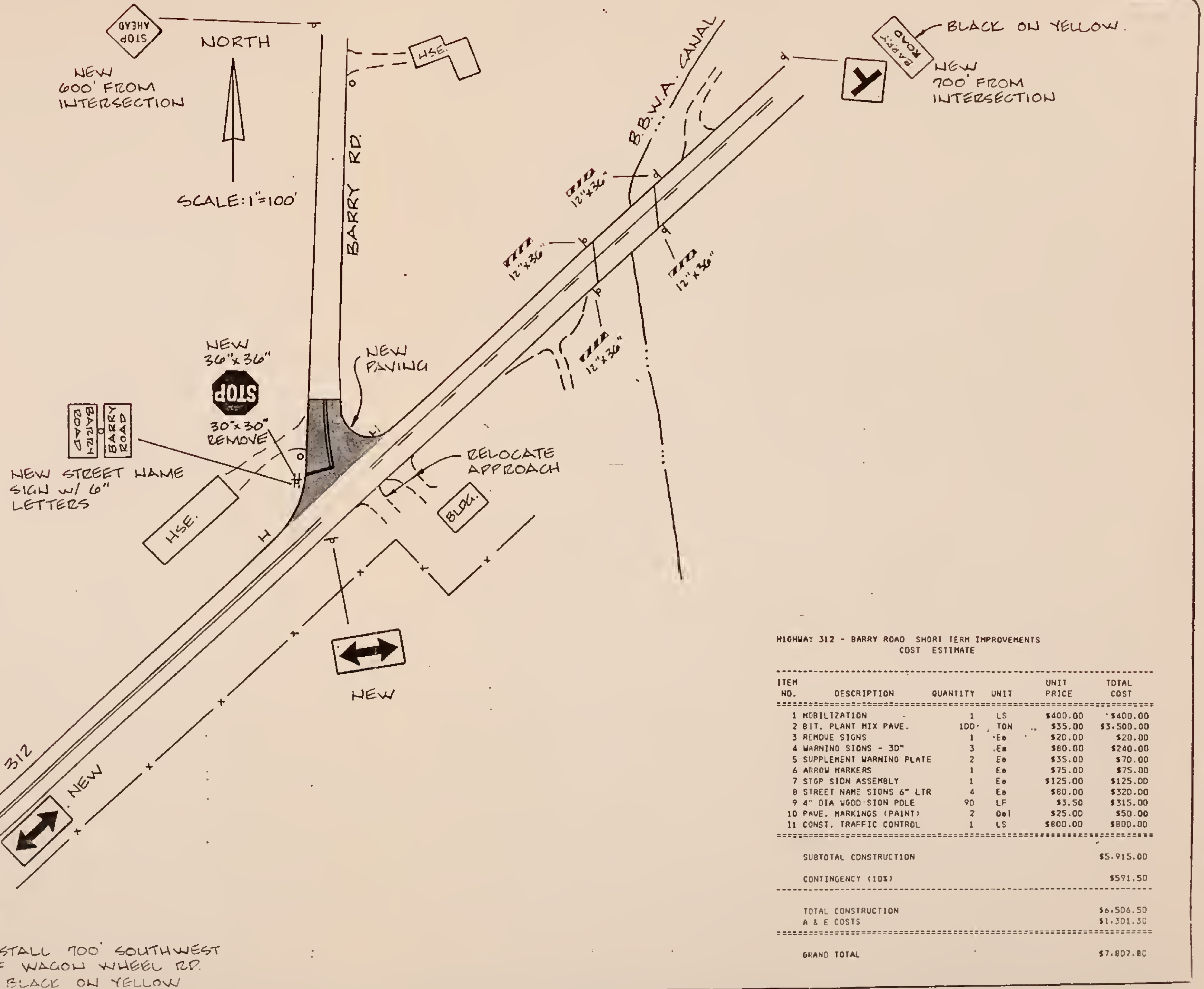
ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 312 - BARRY ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	2	0	-15.0%	-0.3	0.0
ANGLE	0	0	0.0%	0.0	0.0
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	1	-70.0%	0.0	-0.7
REAR END	2	0	-50.0%	-1.0	0.0
SINGLE VEHICLE	0	1	-30.0%	0.0	-0.3
PEDESTRIAN	0	0	0.0%	0.0	0,0
OTHER	0	3	-10.0%	0.0	-0.3
TOTALS :	4	5	***	-1.3	-1.3

% REDUCTION IN INJURY/FATAL ACCIDENTS = -32.5%

% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -26.0%



HIGHWAY 312 - BARRY ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1	LS	$400.00	$400.00
2	BIT. PLANT MIX PAVE.	100	TON	$35.00	$3,500.00
3	REMOVE SIGNS	1	Ea	$20.00	$20.00
4	WARNING SIGNS - 30"	3	Ea	$80.00	$240.00
5	SUPPLEMENT WARNING PLATE	2	Ea	$35.00	$70.00
6	ARROW MARKERS	1	Ea	$75.00	$75.00
7	STOP SIGN ASSEMBLY	1	Ea	$125.00	$125.00
8	STREET NAME SIGNS 6" LTR	4	Ea	$80.00	$320.00
9	4" DIA WOOD SIGN POLE	90	LF	$3.50	$315.00
10	PAVE. MARKINGS (PAINT)	2	Gal	$25.00	$50.00
11	CONST. TRAFFIC CONTROL	1	LS	$800.00	$800.00
	SUBTOTAL CONSTRUCTION				$5,915.00
	CONTINGENCY (10%)				$591.50
	TOTAL CONSTRUCTION				$6,506.50
	A & E COSTS				$1,301.30
	GRAND TOTAL				$7,807.80

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: HWY 312 & BARRY RD. SHORT TERM IMPROVEMENTS

#17

COBURN ROAD - ROSEBUD LANE INTERSECTION

PRIORITY NUMBER 17

SITE DESCRIPTION

Coburn Road is classified as a minor arterial which extends from the Lockwood I-90 Interchange at its northern terminus to a point approximately 5 miles south. It serves as an access road to residential subdivisions along its length as well as recreational and park land.

Rosebud Lane is classified as a collector street and extends from its intersection with Coburn Road to a point approximately 0.5 miles east. It serves as an access road for residential subdivisions east of the intersection area. Because of its location with respect to Old Hardin Road (250 feet north) and the existence of a business located between Old Hardin Road and Rosebud Lane which sells diesel and gasoline, the majority of traffic is circulation traffic accessing the gas station.

EXISTING CONDITIONS

Geometrics. The intersection and surrounding area is shown in the existing condition sketch. As can be seen, the gas station has its parking lot pavement abutting the roadways. Because there is no curb or other means of access control, there is a large area of paving with absolutely no guidance for vehicle movements.

Rosebud Lane is shown to have a 23 foot width. Fences, trees and power poles are located within 2 feet of the shoulder along its length. When combined with parking along the road shoulder a very

narrow effective width is created.

Approach grades along both roads vary significantly. The northbound approach on Coburn Road prior to the intersection is approximately 8 % downgrade and levels out to approximately 4 % in the intersection. The Rosebud Lane approach is flat but is preceded by an 8 % upgrade and a sharp crest vertical curve approximately 300 feet east of the intersection area. The sight distance for the westbound traffic on Rosebud Lane is critically deficient because of the sharp crest curve and the truck parking and maneuvers between the the curve and the intersection (see photos).

Traffic Control Devices. The only existing signing are stop signs on the Rosebud Lane approach and the Coburn Road approach to Old Hardin Road. Because of roadside interference those signs are not completely visible.

There is no striping whatsoever on Rosebud Lane. Coburn has a double yellow centerline on its south approach but it is badly worn.

Traffic Volumes. Traffic volumes at this intersection are relatively low compared to the 13,000 ADT on Old Hardin Road 250 feet north of the intersection. The ADT on Coburn Road is approximately 900 while Rosebud lane carries approximately 600 ADT. Gas station access traffic comprises approximately 45 % of the traffic on Coburn Road and approximately 60 % of the traffic on Rosebud Lane. Therefore very minor volumes would enter this intersection if it were not for the existence of the gas station. Truck traffic accounts for approximately 40 % of all entering traffic.

Traffic Operations. Serious conflict movements occur within the intersection area because of the uncontrolled access and the variety of turning movements.

Some of the conflict movements observed were:

1. Vehicles enter and exit the parking lot area at all angles and speeds.

2. Trucks parked in the lot along Rosebud block the view of other vehicles exiting the lot.

3. The gas station circulation pattern requires semi tractor trailer rigs to access the site via Rosebud Lane. Most of these vehicles exit I-90, turn onto Coburn Road, make a left turn onto Rosebud Lane and then turn left into the site off of Rosebud. The critical sight distance restriction for westbound traffic provides virtually no time for a westbound vehicle to react to a semi in the middle of the road making the left turn.

4. With such a wide paved area, vehicles can line up 2 or 3 abreast prior to executing their exit maneuvers.

8. Because of numerous roadside features and traffic conditions which occupy drivers attention, the intersection approach conditions violate unexpectancy on all approaches.

Accidents. The collision diagram and accident statistics tables shown on the existing condition sketch indicates a variety of accident types almost all of which can be directly related to geometrics and traffic operations required by the gas station location. The majority of accidents were on icy roads and in daylight hours.

SHORT TERM IMPROVEMENTS

The major improvement that must be recommended is to control access from the gas station. Considering the lack of curb and gutter sections within Lockwood, the only feasible method of physical separation between the lot and the street would be pin-down curb sections. The short term improvement sketch illustrates the use of these sections. Since this action may affect parking and circulation for the gas station, implementation of these improvements would have to be discussed with the owners.

Other improvements felt necessary involves advanced warning, positive guidance, regulatory parking controls, tree trimming and standard intersection pavement markings. Pavement widening on Rosebud Lane is felt necessary to accommodate the large percentage of truck traffic and to provide area to accommodate turning movements. Insufficient R/W may cause the need for negotiating with the land owners to acquire adequate width for the street. The exact extent of land required cannot be estimated without a detailed survey.

The cost of these improvements is estimated to be approximately $14,800 based on 1985 unit bid contract prices. It is recommended that the improvements be engineered and plans be developed to insure proper geometric controls. Costs do not include R/W since the exact amount is not known and there may be a possibility that the necessary land could be dedicated in lieu of payment for access improvements.

The cost of improved maintenance at this site was added into the annual cost of improvements for calculation of the benefit/cost ratio.

No long term improvements can be anticipated at this

intersection until traffic volumes increase significantly. When thru traffic entering the intersection comprises the vast majority of total entering traffic, reconsideration of the gas stations access operations should be made.

BENEFITS

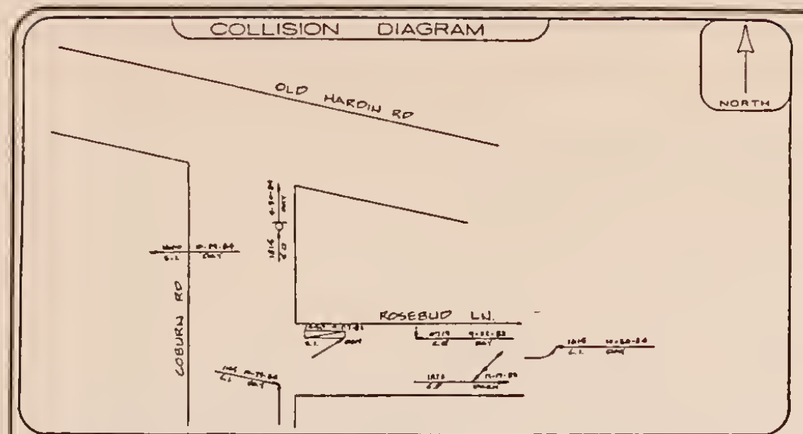
The greatest percentage accident reduction expected from the short term improvements would be predicted for angle accidents. Other accident types would be reduced by a more conservative amount. The basis for anticipated reductions is due mainly to improved access control, advanced warning and positive guidance.

The annual dollar benefit that may be realized is computed to be approximately $4,000. The benefit/cost ratio would therefore be just over 1.0.

FUNDING CONSIDERATIONS

Short term improvements can be funded by established county budget sources, establishment of a special program or by a RSID with the owner of the gas station being responsible for a proportionate share of the costs based on traffic impacts. The share of costs assessable to the owner based on accidents would be 85 %. If it were based on traffic volumes it would be approximately 50 %.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 0
- 1982= 3
- 1983= 0
- 1984= 4

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 2 ANGLE = 29%
- 1 LEFT TURN= 14%
- 0 SIDE SUP.= 0%
- 1 REAR END = 14%
- 1 SINGLE V = 14%
- 2 OTHER = 29%

WEATHER CONDITIONS - % OF TOTAL :
- 5 CLEAR = 71%
- 0 RAIN = 0%
- 2 SNOW = 29%
- 0 FOG = 0%

ROAD CONDITIONS - % OF TOTAL :
- 3 DRY = 43%
- 0 WET = 0%
- 4 ICY = 57%

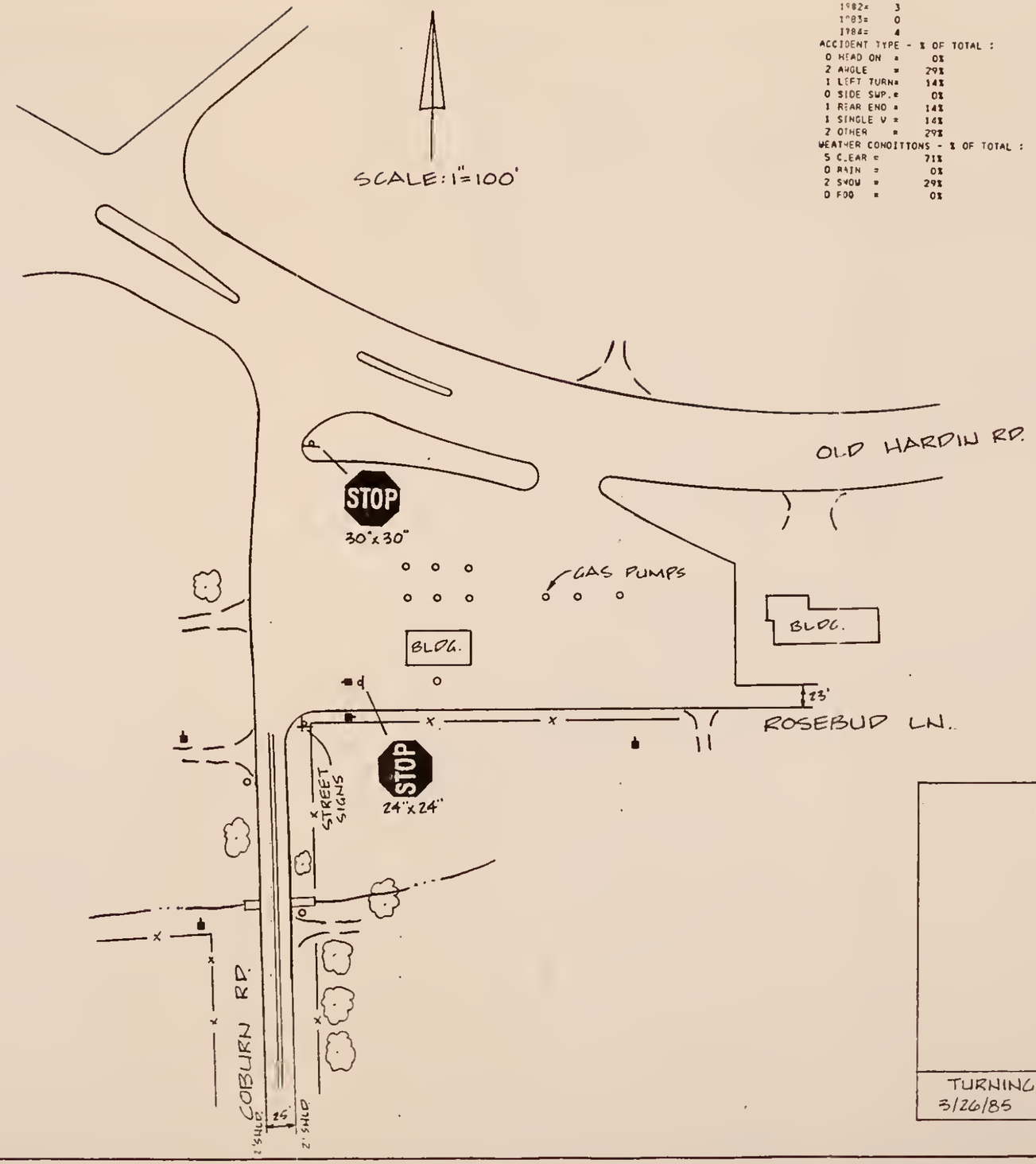
LIGHT CONDITIONS - % OF TOTAL :
- 1 DARK = 14%
- 6 DAY = 86%

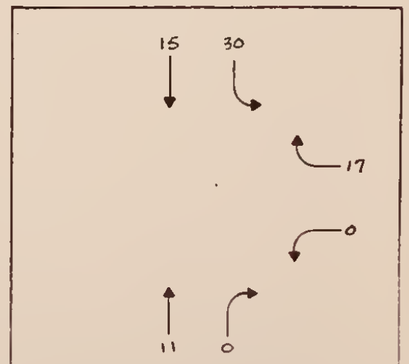
SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 1 INJURY = 14%
- 6 PROP DAM= 86%

ALCOHOL INVOLVED
0 % TOTAL = 0%

NORTH

SCALE: 1"=100'





TURNING MOVEMENTS
3/26/85 3:00-4:00 P.M.

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: COBURN RD. & ROSEBUD LN. EXISTING CONDITIONS

Surveyed By
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Checked By
Date

Revisions
No. Date
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Project No.
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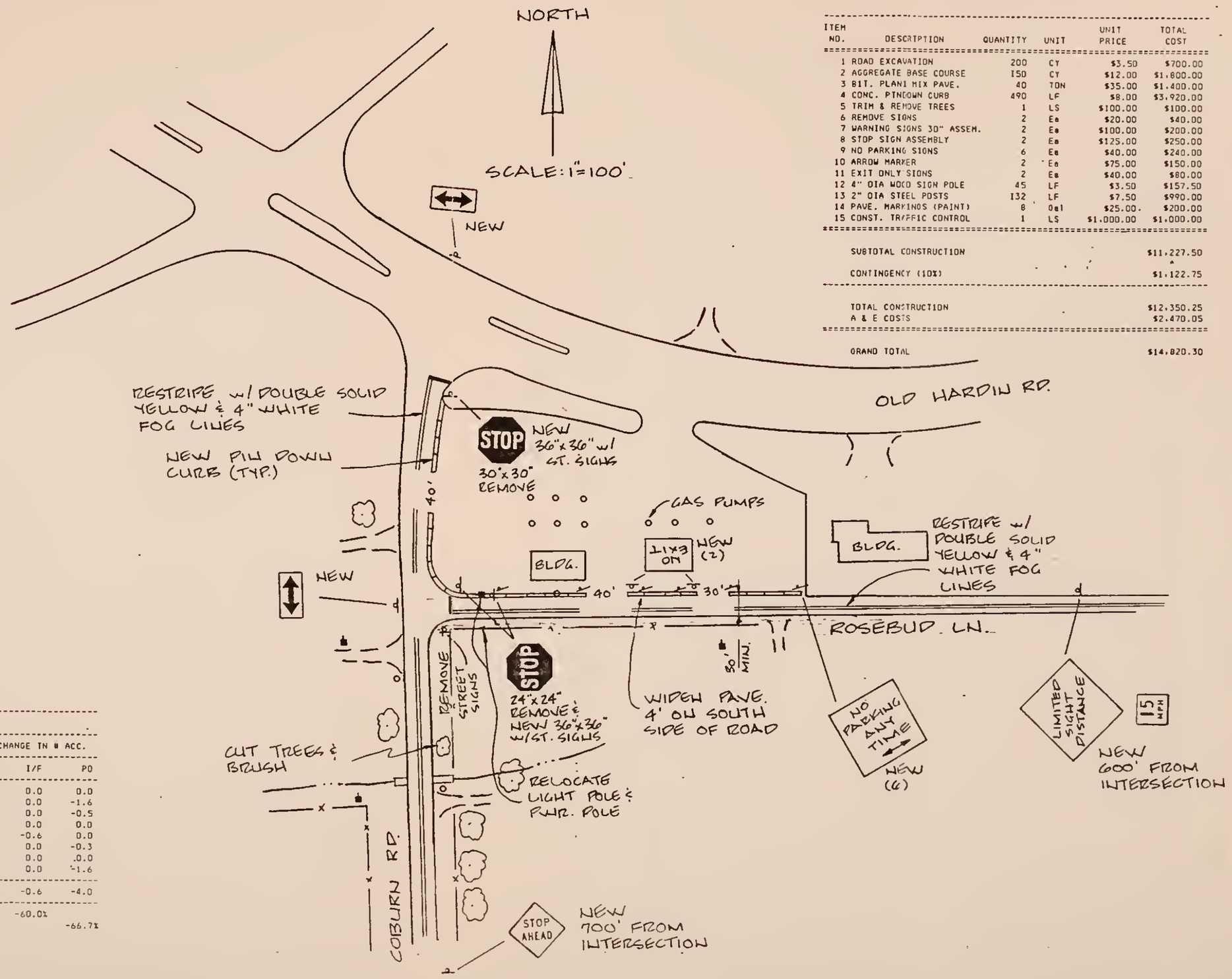

COBURN ROAD - ROSEBUD LANE SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	ROAD EXCAVATION	200	CY	$3.50	$700.00
2	AGGREGATE BASE COURSE	150	CY	$12.00	$1,800.00
3	BIT. PLANT MIX PAVE.	40	TON	$35.00	$1,400.00
4	CONC. PINDOWN CURB	490	LF	$8.00	$3,920.00
5	TRIM & REMOVE TREES	1	LS	$100.00	$100.00
6	REMOVE SIGNS	2	Ea	$20.00	$40.00
7	WARNING SIGNS 30" ASSEM.	2	Ea	$100.00	$200.00
8	STOP SIGN ASSEMBLY	2	Ea	$125.00	$250.00
9	NO PARKING SIGNS	6	Ea	$40.00	$240.00
10	ARROW MARKER	2	Ea	$75.00	$150.00
11	EXIT ONLY SIGNS	2	Ea	$40.00	$80.00
12	4" DIA WOOD SIGN POLE	45	LF	$3.50	$157.50
13	2" DIA STEEL POSTS	132	LF	$7.50	$990.00
14	PAVE. MARKINGS (PAINT)	8	Gal	$25.00	$200.00
15	CONST. TRAFFIC CONTROL	1	LS	$1,000.00	$1,000.00
	SUBTOTAL CONSTRUCTION				$11,227.50
	CONTINGENCY (10%)				$1,122.75
	TOTAL CONSTRUCTION				$12,350.25
	A & E COSTS				$2,470.05
	GRAND TOTAL				$14,820.30

SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : COBURN ROAD - ROSEBUD LANE

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	0	2	-80.0%	0.0	-1.6
LEFT TURN	0	1	-50.0%	0.0	-0.5
SIDE SWIPE	0	0	0.0%	0.0	0.0
REAR END	1	0	-60.0%	-0.6	0.0
SINGLE VEHICLE	0	1	-30.0%	0.0	-0.3
PEDESTRIAN	0	0	0.0%	0.0	.0.0
OTHER	0	2	-80.0%	0.0	-1.6
TOTALS :	1	6	***	-0.6	-4.0

% REDUCTION IN INJURY/FATAL ACCIDENTS = -60.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -66.7%

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: COBURN ST. & ROSEBUD LN. SHORT TERM IMPROVEMENTS

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Project No.
Sheet No.
of

#18

HIGHWAY 312 - DRURY LANE INTERSECTION

PRIORITY NUMBER 18

SITE DESCRIPTION

This intersection is one of six intersections on Highway 312 which is described in the main body of this report. Drury Lane is an east-west rural county road which intersect Highway 312 north of Billings. It extends east of Highway 312 approximately 1.5 miles.

One other road enters this intersection from the south. Pioneer Road is a north-south rural road which intersects Highway 312 at this site. Pioneer Road is further described in Dover Road - Pioneer Road section of this report.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection has four tangent approaches and the skew angles of the intersection is created by Highway 312 which intersects the county roads at a 45 degree angle. The separation of approaches and the angle of intersection creates a section on Highway 312 which is difficult to control with conventional traffic control devices.

Opposite the intersection on the north side of Highway 312 are two wide dirt approaches to a farm and fields. A maze of irrigation ditches, trees, power poles and other structures are concentrated in the intersection area. These roadside features are largely missing along the approach roads prior to the intersection.

All of the approach grades to the intersection are less than 1 %. Roadside ditches for the most part are shallow with moderate

inslopes except for in the intersection area where steep ditches exist.

Traffic Control Devices. Signing at the intersection is minimal. Stop signs for the minor roads exist but they are inadequate in size and placement. The irrigation crossing and geometrics of the intersection are so restrictive that hazard markers were installed which locate the sharp drop to the channel.

Pavement markings on Highway 312 were freshly painted and conformed to MUTCD standards. No trace of pavement markings were found on the minor approaches.

Traffic Volumes. Minor road traffic at this intersection is very light but Highway 312 traffic is moderately heavy. The ADT on Highway 312 is approximately 5,400. Pioneer Road has an ADT of 500 and Drury has 400 ADT.The peak evening count does not indicate a full representation of turning movements which would occur during a normal weekday.

Traffic Operations. As is the case for most Highway 312 intersections the operating speed is 55 mph and in excess. The relatively high volume of traffic combined with the site geometrics leaves little room for error in judging the time required to make decisions regarding direction of travel or reaction to unexpected turning movements. The right turn movement from Highway 312 eastbound to Drury seems to be the most unexpected of all the movements since the actual approach cannot be seen until the driver is almost

northeast of Pioneer Road. It is apparent that the speed of vehicles turning is too fast for conditions because anticipation of the turn is difficult.

The geometrics of this intersection causes misinterpretation of turn signals for left turn movements from Highway 312. Each left turn signal has two potential vehicle paths.

In addition to misinterpretation of driver's intent, the left turn movements from Highway 312 is made blind because of the preponderance of vision obstacles in the southeast quadrant of the intersection. Avoidance maneuver area does not exist and any encounter with roadway hazards would either result in a collision or a severe off road accident.

A plain board barricade in this area was probably installed to prevent drivers from misjudging the turn and falling into the ditch. The barricade is more of a hazard than a help since it is not strong enough to repel a vehicle. It could only cause more extensive damage to errant vehicle's occupants.

The minor road approaches share a common problem related to background interference. The flat topography draws drivers attention toward the horizon. In this case there are buildings and trees setback from the intersection area which distracts from the location of the intersection point. The worst approach is Pioneer Road especially at night when a farm yard light glares into the eyes of northbound drivers obscuring the stop sign. The yard light also has the appearance of roadway lighting which causes the driver to believe that the intersection is farther north than it actually is.

Accidents. There were 7 accidents total during the four year reporting period. The majority of accidents were split equally between rear end, single vehicle and pedestrian type accidents. At least 58 % of the accidents were related to the noted operational problems. The pedestrian accidents, which result in a high severity at this site, cannot be directly related to the operational problems. The contributing circumstance in those instances was probably the lack of a parking lane or adequate shoulder width. Pedestrian traffic along Highway 312 is almost exclusively emergency type traffic and is rare.

The majority of accidents occurred on dry pavement. However, all but one accident occurred at night. Lack of adequate delineation for the unusual geometrics and interference from off road area lighting contribute to this statistic.

SHORT TERM IMPROVEMENTS

Unexpectancy of conditions for approaching traffic is clearly a contributing factor to the accident experience. The angle of intersection skews and uncontrolled pavement area along with the absence of advanced warning and guidance causes the relative problem with expectancy.

The short term improvements sketch details the recommendations to alleviate these problems. Advanced warning of the intersection from all approach legs is considered necessary and the supplementary plate which identifies the approaching road would improve the expectancy for drivers intent on turning. Advanced warning of the stop conditions on the minor approaches will provide the necessary information that the topographic conditions fail to provide.

Reconstruction of the approaches would accommodate the minor approach traffic's existing movements by providing an area to stop at a near 90 degree angle to Highway 312. It would also provide a marginal separation between the intersections for more precise delineation of conflicting turning vehicle paths. Extending the irrigation culvert will provide room to develop a larger radius and accommodate removal of structures which inhibit sight distance in the southeast quadrant of the intersection.

The cost of the recommended improvements is estimated to be $30,400 based on 1985 unit bid contract prices and includes Engineering and administrative fees.

BENEFITS

By applying advanced warning techniques, realigning the approach conditions and increasing information to the motorist regarding the exact location of the intersection, the average reduction in accident experience is estimated to be approximately 35 % dependant upon the type of accident. Rear end accidents would experience the greatest reduction at 60 %.

The annual dollar benefit is thus computed to be approximately $10,600. The benefit/cost ratio would therefore be in excess of 1.6 which is above average for improvements requiring roadway reconstruction.

LONG TERM IMPROVEMENTS

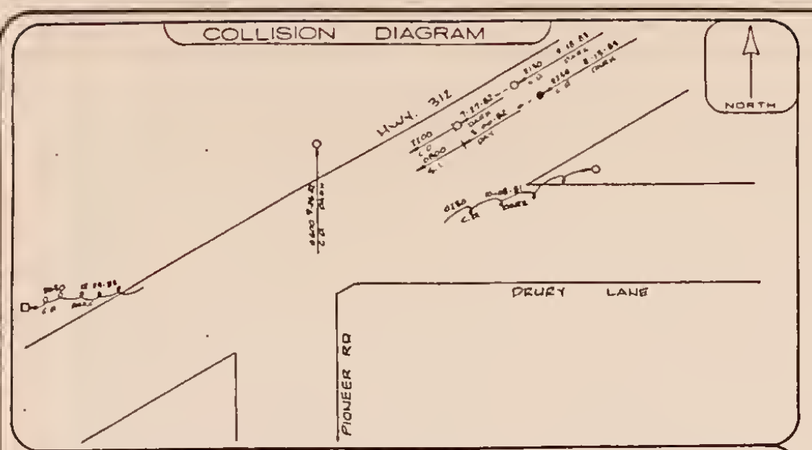
Future improvements should consider rerouting of either Drury or Pioneer to create a minor intersection south of Highway 312 thus

providing only on approach to Highway 312. This would reduce the total number of conflict points on the higher approach speed intersection. Any significant increases in minor road traffic or increases in turning movements have the potential to create serious operational and safety problems at this intersection. The county planning agency should be made aware of potential impacts that traffic generating developments may have on this intersection so that they can evaluate any developments that may be proposed in the future.

FUNDING CONSIDERATIONS

These improvements could possibly be completed with the counties annual road maintenance fund or be included in a special program. Because of the location along Highway 312 a special account to provide special improvements through a general RSID may be necessary. This location is also recommended as a candidate for priority ranking in the MDOH off system safety fund program.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981 = 1
- 1982 = 3
- 1983 = 3
- 1984 = 0

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 0 ANGLE = 0%
- 0 LEFT TURN = 0%
- 0 SIDE SWP. = 0%
- 2 REAR END = 29%
- 2 SINGLE V = 29%
- 3 OTHER = 43%

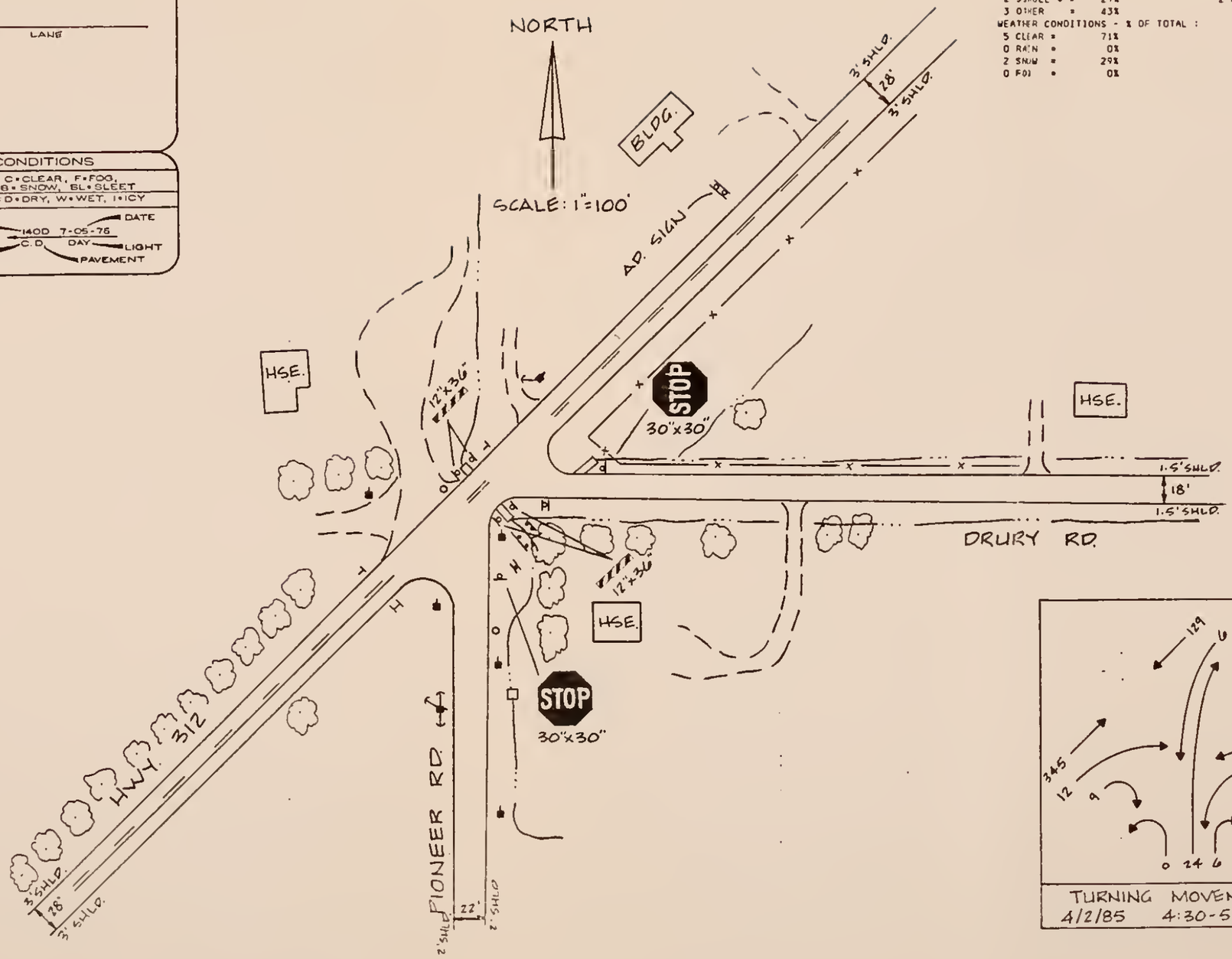
WEATHER CONDITIONS - % OF TOTAL :
- 5 CLEAR = 71%
- 0 RAIN = 0%
- 2 SNOW = 29%
- 0 FOG = 0%

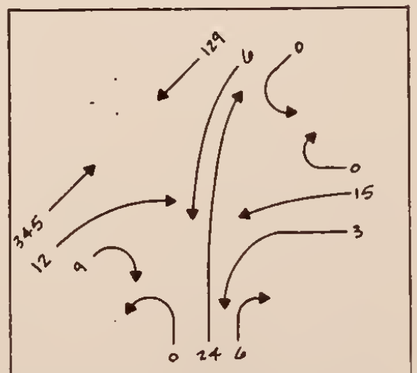
ROAD CONDITIONS - % OF TOTAL :
- 6 DRY = 86%
- 0 WET = 0%
- 1 ICY = 14%

LIGHT CONDITIONS - % OF TOTAL :
- 6 DARK = 86%
- 1 DAY = 14%

SEVERITY - % OF TOTAL :
- 1 FATAL = 14%
- 4 INJURY = 57%
- 2 PROP DAM = 29%

ALCOHOL INVOLVED
4 % TOTAL = 57%





TURNING MOVEMENTS
4/2/85 4:30-5:30 P.M.

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: HWY 312 & DRURY RD. EXISTING CONDITIONS

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Date

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No. Date
No. Date
No. Date
No. Date

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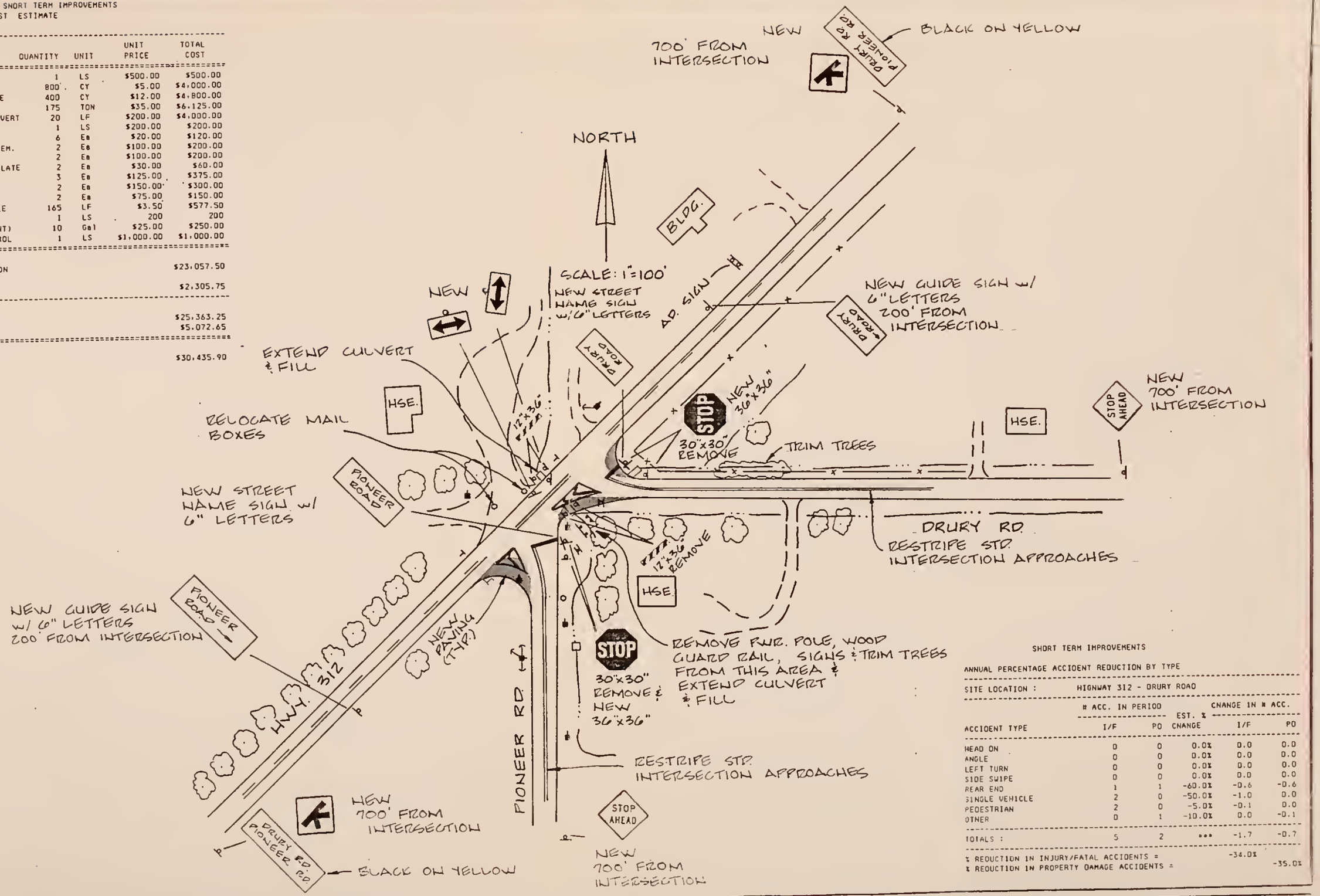
of

HIGHWAY 312 - DRURY ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATON	1	LS	$500.00	$500.00
2	FILL BORROW	800	CY	$5.00	$4,000.00
3	AGGREGATE BASE COURSE	400	CY	$12.00	$4,800.00
4	BIT. PLANT MIX PAVE	175	TON	$35.00	$6,125.00
5	EXTEND CONC. BOX CULVERT	20	LF	$200.00	$4,000.00
6	TRIM & REMOVE TREES	1	LS	$200.00	$200.00
7	REMOVE SIGNS	6	Ea	$20.00	$120.00
8	WARNING SIGN 30" ASSEM.	2	Ea	$100.00	$200.00
9	WARNING SIGN 36"	2	Ea	$100.00	$200.00
10	SUPPLEMENT WARNING PLATE	2	Ea	$30.00	$60.00
11	STOP SIGN ASSEMBLY	3	Ea	$125.00	$375.00
12	GUIDE SIGNS	2	Ea	$150.00	$300.00
13	ARROW MARKER	2	Ea	$75.00	$150.00
14	4" DIA WOOD SIGN POLE	165	LF	$3.50	$577.50
15	RELOCATE MAILBOXES	1	LS	200	200
16	PAVE. MARKINGS (PAINT)	10	Gal	$25.00	$250.00
17	CONST. TRAFFIC CONTROL	1	LS	$1,000.00	$1,000.00
	SUBTOTAL CONSTRUCTION				$23,057.50
	CONTINGENCY (10%)				$2,305.75
	TOTAL CONSTRUCTION				$25,363.25
	A & E COSTS				$5,072.65
	GRAND TOTAL				$30,435.90



SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 312 - DRURY ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	0	0.0%	0.0	0.0
ANGLE	0	0	0.0%	0.0	0.0
LEFT TURN	0	0	0.0%	0.0	0.0
SIDE SWIPE	0	0	0.0%	0.0	0.0
REAR END	1	1	-60.0%	-0.6	-0.6
SINGLE VEHICLE	2	0	-50.0%	-1.0	0.0
PEDESTRIAN	2	0	-5.0%	-0.1	0.0
OTHER	0	1	-10.0%	0.0	-0.1
TOTALS :	5	2	***	-1.7	-0.7

% REDUCTION IN INJURY/FATAL ACCIDENTS = -34.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -35.0%

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Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: HWY 312 - DRURY RD SHORT TERM IMPROVEMENTS

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No. Date

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HIGHWAY 312 - HUNTLEY APPROACH ROAD INTERSECTION

PRIORITY NUMBER 19

SITE DESCRIPTION

The intersection of Highway 312 and Huntley Approach Road is one of six separate accident cluster sites along Highway 312 that are included in this study. A detailed discussion regarding Highway 312 can be found within the main body of this report.

Huntley Approach Road extends south of the intersection for approximately 1/2 mile to the town of Huntley, Montana. It is one of three access points to Huntley. It serves as the main route between Huntley and the area between and including the northern fringes of Billings.

EXISTING CONDITIONS

Geometrics. The existing condition sketch indicates that this intersection is a skewed T intersection with the leg of the T being at a 45 degree angle. Highway 312 at this location is on a east-west bearing and is tangent for an extended distance on each side of the intersection. A Yellowstone River crossing structure is located approximately 300 feet west of the intersection.The Huntley Approach Road is tangent at the intersection but it is preceded by a series of reverse curves along its length. The width is constant even along the curve sections.

Steep inslopes are present on all approaches and fill sections are moderate to high. Huntley Approach Road south of the site has very steep (1:1) inslopes and high fill sections. When combined with the

narrow roadway and curves, it presents extreme hazards for errant vehicles.

The approach grades on Highway 312 are less than 1 % while the Huntley approach is on a 5 % upgrade.

Traffic Control Devices. The only warning signs found at the site was a intersection warning sign for the westbound direction. Old style roadside table signs are in place for both Highway 312 travel directions. A standard size stop sign is located on the Huntley approach in such a manner as to hide it behind roadside brush.

Standard intersection pavement markings exist on Highway 312. No evidence of pavement markings exist on the Huntley Approach Road.

Traffic Volumes. Total entering traffic at this intersection is moderate with heavy turning movements during the peak hours. During the evening peak hour the eastbound thru movement is the highest percentage movement at 42 % of total approach traffic. The left turn movement from Huntley to westbound Highway 312 is the next highest at 26 % of total traffic.

The ADT for Highway 312 is computed to be 2,200 west of Huntley and 1,300 ADT east. On Huntley Approach Road the ADT is 1,000. This would indicate that the south and east legs of the intersection are approximately equal and Shepherd Road is a major contributor to Highway 312 traffic volumes at this point.

Traffic Operations. The most obvious operational problem observed is associated with the left turn movement from Huntley

Approach Road to Highway 312. A large pavement area is provided and approximately 60 % of the approach traffic use the extra pavement width to position vehicles near 90 degrees to the highway to gain sight distance in both directions. Those vehicles that don't adjust the angle of their vehicle don't obtain adequate sight distance to enter the highway. This condition may or may not be apparent to some of those drivers and they may assume that they have a sufficient line of sight.

Prevailing speeds on Highway 312 are typical of high speed rural highways. Vision of the approach for eastbound traffic is obscured by large trees and bridge railing. Therefore the exact location is not perceived far enough in advance. The resultant deceleration is more than what would be expected. Since the radius for that turn is quite large the speed is not uncomfortable but the speed is too fast for geometrics of the Huntley Approach Road.

Accidents. Observed expectancy and visual problems were directly related to at least 3 of the 6 accidents in the four year reporting period. The majority of accidents occurred on clear and dry roads during hours of darkness.

The sight distance problems are not as acute as woul be indicated by the accident history since no angle accidents occurred. The severity is also not as high as could be expected considering the steep embankments and higher speed operation.

SHORT TERM IMPROVEMENTS

Improved motorist information, delineation and improved

geometrics would be necessary to reduce future accident experience and potential for accidents. The short term improvement sketch details the recommended signs and markings which conform to MUTCD requirements. Advanced warning on all approaches should provide the necessary information concerning intersection control. Reconstructing part of the intersection and restriping to delineate the proper approach positioning for all vehicles along with removal of sight restrictions, will greatly aid intersection operations and reduce the potential for more severe accidents. Other improvements are recommended to bring the intersection more into conformance with currently accepted standards of roadway design.

The cost of these improvements is estimated to be approximately $21,300 based on 1985 unit bid contract prices. The improvements should be Engineered to insure proper geometric controls consistent with current Traffic Engineering standards.

LONG TERM IMPROVEMENTS

Long term improvements at this intersection will undoubtedly be required as more development occurs in and around Huntley, Montana. Improvements to Highway 312 should generally follow the recommendations indicated in the main body of this report.

The Huntley Approach will undoubtedly have to be reconstructed in the future. At the that time it would be imperative that the intersection approach be moved east a minimum of 200 feet from its present location and it should intersect Highway 312 at more nearly a 90 degree angle.

BENEFITS

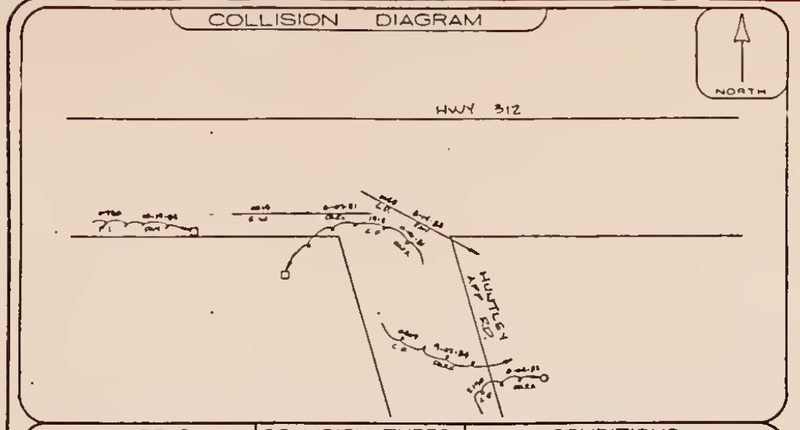
The average accident reduction expected at this site would be approximately 60 % for the type of accidents previously experienced. No definitive value could be placed on reduction in angle accidents that may occur when traffic volumes increase in the future.

The annual dollar benefit that may be realized is computed to be approximately $4,700. The benefit/cost ratio in this case is approximately 1.0. At this level of traffic volumes and accident experience, the project is marginally justified.

FUNDING CONSIDERATIONS

It is recommended that this project be funded through a special county program or through regular maintenance funds. Since it is so far down on the priority list, it may be advised that the signing and striping could be completed as an interim measure while waiting for funding sources.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT: D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 DATE 7-05-75
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D. DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 2
- 1982= 1
- 1983= 2
- 1984= 1

ACCIDENT TYPE - % OF TOTAL :
- 1 HEAD ON = 17%
- 0 ANGLE = 0%
- 0 LEFT TURN= 0%
- 0 SIDE SWP.= 0%
- 0 REAR END = 0%
- 3 SINGLE V = 50%
- 2 OTHER = 33%

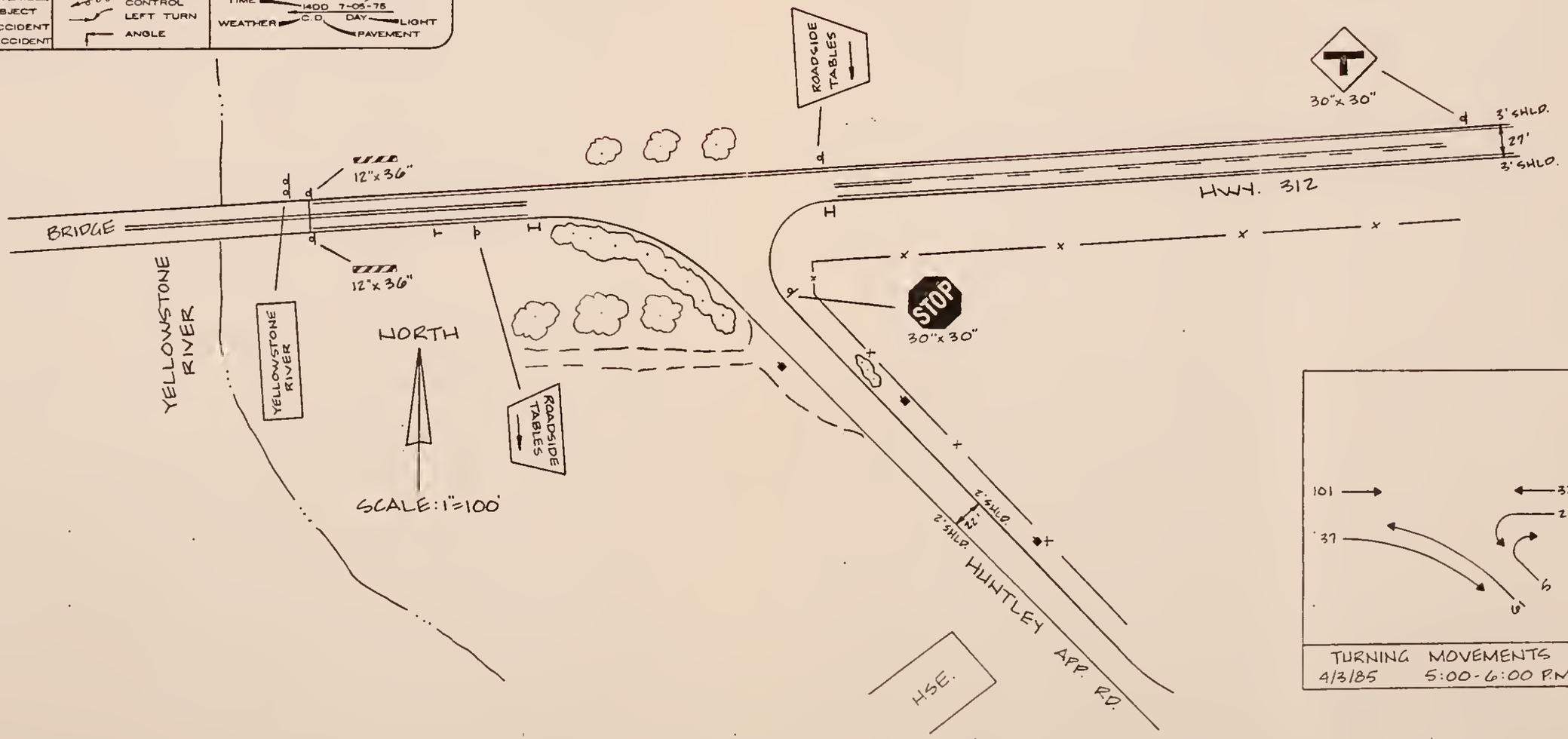
WEATHER CONDITIONS - % OF TOTAL :
- 4 CLEAR = 67%
- 1 RAIN = 17%
- 0 SNOW = 0%
- 1 FOG = 17%

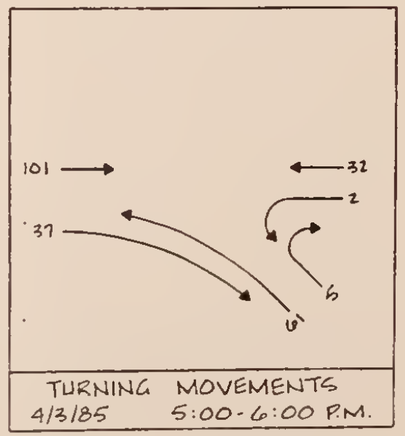
ROAD CONDITIONS - % OF TOTAL :
- 4 DRY = 67%
- 1 WET = 17%
- 1 ICY = 17%

LIGHT CONDITIONS - % OF TOTAL :
- 4 DARK = 67%
- 2 DAY = 33%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 1 INJURY = 17%
- 5 PROP DAM= 83%

ALCOHOL INVOLVED
2 % TOTAL = 33%





TURNING MOVEMENTS
4/3/85 5:00-6:00 P.M.

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN
404 N. 31st
BILLINGS MT 59101
Ph (406) 248-5080

Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: HWY. 312 & HUNTLEY APP. RD. EXISTING CONDITIONS

Surveyed By
Designed By
Drawn By
Checked By
Date

Revisions
No. Date
No. Date
No. Date
No. Date

Project No.
Client No.
Sheet No.
of

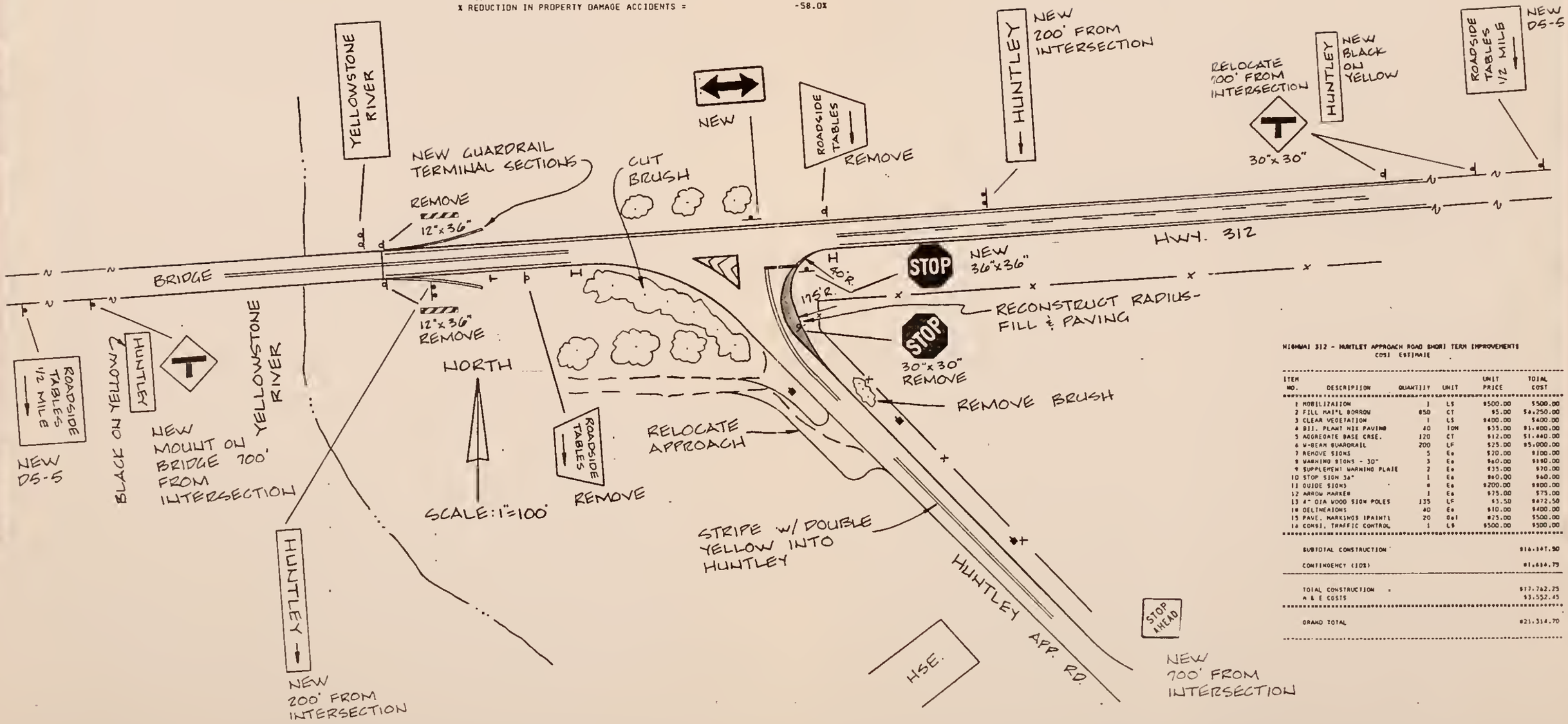
SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIDENT REDUCTION BY TYPE

SITE LOCATION : HIGHWAY 312 - HUNTLEY APPROACH ROAD

ACCIDENT TYPE	# ACC. IN PERIOD I/F	# ACC. IN PERIOD PD	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PD
HEAD ON	0	1	-50%	0.0	-0.5
ANGLE	0	0	0%	0.0	0.0
LEFT TURN	0	0	0%	0.0	0.0
SIDE SWIPE	0	0	0%	0.0	0.0
REAR END	0	0	0%	0.0	0.0
SINGLE VEHICLE	1	2	-60%	-0.6	-1.2
PEDESTRIAN	0	0	0%	0.0	0.0
OTHER	0	2	-60%	0.0	-1.2
TOTALS :	1	5	***	-0.6	-2.9

% REDUCTION IN INJURY/FATAL ACCIDENTS = -60.0%
% REDUCTION IN PROPERTY DAMAGE ACCIDENTS = -58.0%



HIGHWAY 312 - HUNTLEY APPROACH ROAD SHORT TERM IMPROVEMENTS
COST ESTIMATE

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZATION	1	LS	$500.00	$500.00
2	FILL MAT'L BORROW	850	CY	$5.00	$4,250.00
3	CLEAR VEGETATION	1	LS	$400.00	$400.00
4	BIT. PLANT MIX PAVING	40	TON	$55.00	$1,800.00
5	AGGREGATE BASE CRSE.	120	CY	$12.00	$1,440.00
6	W-BEAM GUARDRAIL	200	LF	$25.00	$5,000.00
7	REMOVE SIGNS	5	Ea	$20.00	$100.00
8	WARNING SIGNS - 30"	3	Ea	$60.00	$180.00
9	SUPPLEMENT WARNING PLATE	2	Ea	$35.00	$70.00
10	STOP SIGN 36"	1	Ea	$60.00	$60.00
11	GUIDE SIGNS	8	Ea	$200.00	$800.00
12	ARROW MARKER	1	Ea	$75.00	$75.00
13	4" DIA WOOD SIGN POLES	135	LF	$3.50	$472.50
14	DELINEATORS	40	Ea	$10.00	$400.00
15	PAVE. MARKINGS (PAINT)	20	Gal	$25.00	$500.00
16	CONST. TRAFFIC CONTROL	1	LS	$500.00	$500.00
	SUBTOTAL CONSTRUCTION				$16,347.50
	CONTINGENCY (10%)				$1,634.75
	TOTAL CONSTRUCTION				$17,782.25
	A & E COSTS				$3,532.45
	GRAND TOTAL				$21,314.70

P.C. MARVIN & ASSOCIATES — Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN I, 404 N. 31st, BILLINGS, MT. 59101, Ph. (406) 248-5068

Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: HWY. 312 & HUNTLEY APP RD SHORT TERM IMPROVEMENTS

Surveyed By / Designed By / Drawn By / Checked By / Date

Revisions: 1 Date / 2 Date / 3 Date / 4 Date

Project No. / Sheet No. / Contract No. / of

KING AVENUE WEST - 32ND STREET WEST INTERSECTION

PRIORITY NUMBER 20

SITE DESCRIPTION

Both King Avenue West and 32nd Street West are Principal Arterial Streets within the Billings Urban Area. King Avenue West is an east-west street which originates at the West Billings, I-90 Interchange and extends past its intersection with 32nd Street West to serve rural access points west to 88th Street West. Thirty Second Street West originates south of Hesper Road and continues past the intersection site north to Broadwater Avenue.

The intersecting streets were originally built as a part of the county road system and served the low traffic volumes associated with rural access and farm to market roads for many years. Within the recent past, westward expansion of the Billings Urban environs has created a significant degree of residential and commercial development which has been witnessed by annual traffic growth rates as high as 60 %.

EXISTING CONDITIONS

Geometrics. Pertinent geometric features of this site are shown on the existing condition sketch. The following conditions also exist :

1. The approach grades are less than 1% on all approaches.
2. Pavement conditions vary from fair to good.
3. Roadside ditch sections incorporate a 2:1 side slope and extend between 15 and 20 feet from the shoulder.

4. N. 32nd Street W. had been widened to accommodate an additional turn lane at the intersection when the Harvest Subdivision northwest of the intersection was constructed.
5. Approaches to the businesses in the southeast quadrant have recently been paved and the ditch depressions between approaches fairly well define the access points.

Traffic Control Devices. Whatever pavement markings had existed at this intersection are not visible unless scrutinized closely. It appears that the King Avenue West approaches were not marked according to intersection approach standards.

No signing or delineation relative to the intersection approaches exist on King Avenue West. The regulatory and warning signs on 32nd Street West are appropriate in application, however the stop sign on the south approach is perceptually impaired due to poles and ad signs combined with poor setback placement.

Traffic Volumes. During the course of this study the intersection of S. 24th Street W. and King Avenue W. east of the site was under construction and therefore reliable volumes counts for 1985 could not be obtained. The turning movement volumes shown on the existing condition sketch were extracted from a study for the Harvest Subdivision Elementary School completed by Marvin & Associates in 1984.

The average daily traffic volumes for 1984 were computed by factoring this and one other count taken during the proposed school crossing period. The following is a summary of 1980, 1984 and

estimated 1986 average daily traffic volumes based on the aforementioned elementary school study.

Average Daily Traffic Volumes

Street Approach	1980 ADT	1984 ADT	1986 ADT(Est)
King Ave W., East App.	4,500	7,600	9,100
King Ave W., West App.	4,400	5,200	10,900
32nd St. W., North App.	600	3,900	6,800
32nd St. W., South App.	600	2,700	3,000

While the 1985 Transportation Plan Update is currently being made, no definitive 20 year projection of traffic volumes can be made. Based on the total of known developments it can be assumed that the ADT on King Ave W. and 32nd St. W. will increase to 15,000 and 7,000 respectively within the next 10 to 15 years.

Traffic Operations. During traffic observation periods at the peak evening hour and during mid afternoon, it was noted that delay for both side street (32nd St. W.) traffic and King Ave W. left turn traffic is beginning to be significant. Further traffic volume increases will undoubtedly stress driver tolerance to a point where gap acceptance will be made without sufficient caution and accidents will increase proportionately.

The lack of noticeable roadside friction for sizeable distances on each side of the intersection on King Avenue West causes vehicle speeds to be greater than the posted 45 mph. The estimated 85% speed

would probably be closer to 55 mph than 45 mph. The degree of speed combined with heavy turning movements at the intersection, flat and open topography and an inadequate pavement width for avoidance maneuvering, create a potentially dangerous situation for inattentive drivers.

The added pavement width which was constructed on the north approach to accommodate an extra turn lane creates a sight distance problem by stacking traffic side by side. Because of the queue formations and delays, drivers extend their lead into the intersection area and block the view of adjacent drivers. This problem is evident when examining the collision diagram. Approximately 5 accidents may have been related to this problem in 1983 and 1984.

Future operations will be complicated further when school children are required to cross King Avenue W. between the new elementary school north of the site and the mobile home subdivision south of the site. The elementary school traffic study has already documented the probability of insufficient gaps to accommodate those crossings.

Accidents. Trends at this intersection clearly point to the proportionate increase in accidents following volume increases. The average number of accidents in 1983-84 was 3 times that of the average in 1981-82. With increased volumes and turning movements, speeds have been reduced somewhat and therefore property damage accidents are increasing faster than injury accidents. Even though the intersection is not signalized, rear end accidents have begun to occur because of

turning movements from King Avenue W.

SHORT TERM IMPROVEMENTS

This site is unique among the twenty study sites in that it is an urban intersection and the need for improvements has previously been documented. Since the east half of this intersection is within the jurisdiction of Yellowstone County and contemplated improvements must be shared by the County and the City of Billings, this site was included to more accurately determine the extent of improvements required.

Signalization of the intersection is marginally warranted at present. With construction of the elementary school scheduled for completion prior to the 1986-1987 school year, design and construction of the signal to accommodate pedestrian crossings must be complete prior to that time. In addition to signalization, auxilary left turn lanes must be provide to accomodate the high percentage of turning movements. The auxillary lanes are not only necessary for capacity of the intersection but they are essential to reduce the potential for rear end accidents which will undoubtably increase with signalization.

The short term improvements sketch is a preliminary design of improvements which could be coordinated with long term future improvements. The associated cost estimate of $217,000 is itemized on the sketch and is based on 1985 unit bid averages and incorporates estimated A&E costs.

Long term improvements contemplate a 5 lane roadway section to handle in excess of 15,000 ADT. Those improvements would include curb

and gutter, possibly a raised median, a drainage system and continuous lighting as part of a major arterial upgrade along King Avenue West. It would probably be built in conjunction with subdivision or site development improvements adjacent to King Avenue West.

BENEFITS

The benefit portion of the B/C ratio computations listed in Table 10 of this report includes an annual dollar amount of $ 3,950 for improved efficiency. In most cases signalization causes increased delay and therefore a negative benefit. In this case, the addition of auxiliary turn lanes would provide an extra level of service increase sufficient to realize a net efficiency benefit. Vehicle delay calculations were based on average traffic volumes over its estimated 10 year useful life. The cost component of delay was based on user time = $5.40 / hour and vehicle costs = $ 0.35 / hour.

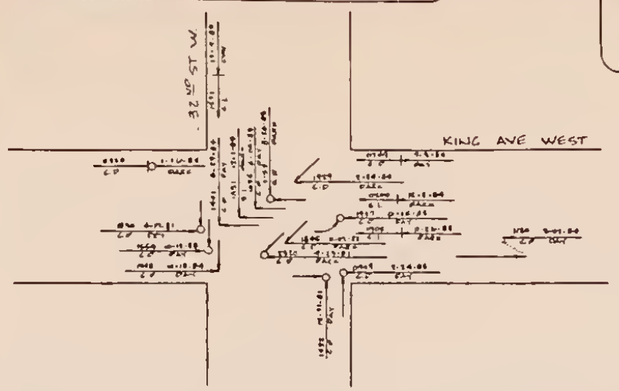
The remaining portion of the benefit calculation is the standard Montana Department of Highways computation procedure as formatted in the computer generated Table 10.

FUNDING CONSIDERATIONS

The City of Billings currently has waivers of protest for creation of special improvement districts in the area and therefore could form a district to cover design and construction of these improvements. The exact cost sharing formula is not known at this time but it is assumed that not all of the costs can be derived from area property owners. The remaining must be shared between the City of Billings and Yellowstone County based on jurisdictional control (50 %

City and 50 % County). The source of local governmental funding for this type of project may not be easily found and therefore it is recommended that the possibility of using State and Federal Safety funds be investigated. If this project is included in the statewide priority list it should be remembered that the analysis procedure utilized within this study does not accurately reflect the urgency associated with a project of this nature. There is no method to include the potential severity of future accidents that may occur if the improvements are not made.

COLLISION DIAGRAM



SYMBOLS	COLLISION TYPES	CONDITIONS
VEHICLE PATH	REAR END	WEATHER: C•CLEAR, F•FOG, R•RAIN, S•SNOW, SL•SLEET
PEDESTRIAN PATH	HEAD ON	PAVEMENT D•DRY, W•WET, I•ICY
BACKING VEHICLE	SIDE SWIPE	TIME 1400 7-05-75 DATE
PARKED VEHICLE	OUT OF CONTROL	WEATHER C.D DAY LIGHT
FIXED OBJECT	LEFT TURN	PAVEMENT
FATAL ACCIDENT	ANGLE	
INJURY ACCIDENT		

STATISTICS

ACCIDENTS / YEAR :
- 1981= 3
- 1982= 1
- 1983= 7
- 1984= 8

ACCIDENT TYPE - % OF TOTAL :
- 0 HEAD ON = 0%
- 12 ANGLE = 63%
- 1 LEFT TURN= 5%
- 0 SIDE SWP.= 0%
- 5 REAR END = 26%
- 0 SINGLE V = 0%
- 1 OTHER = 5%

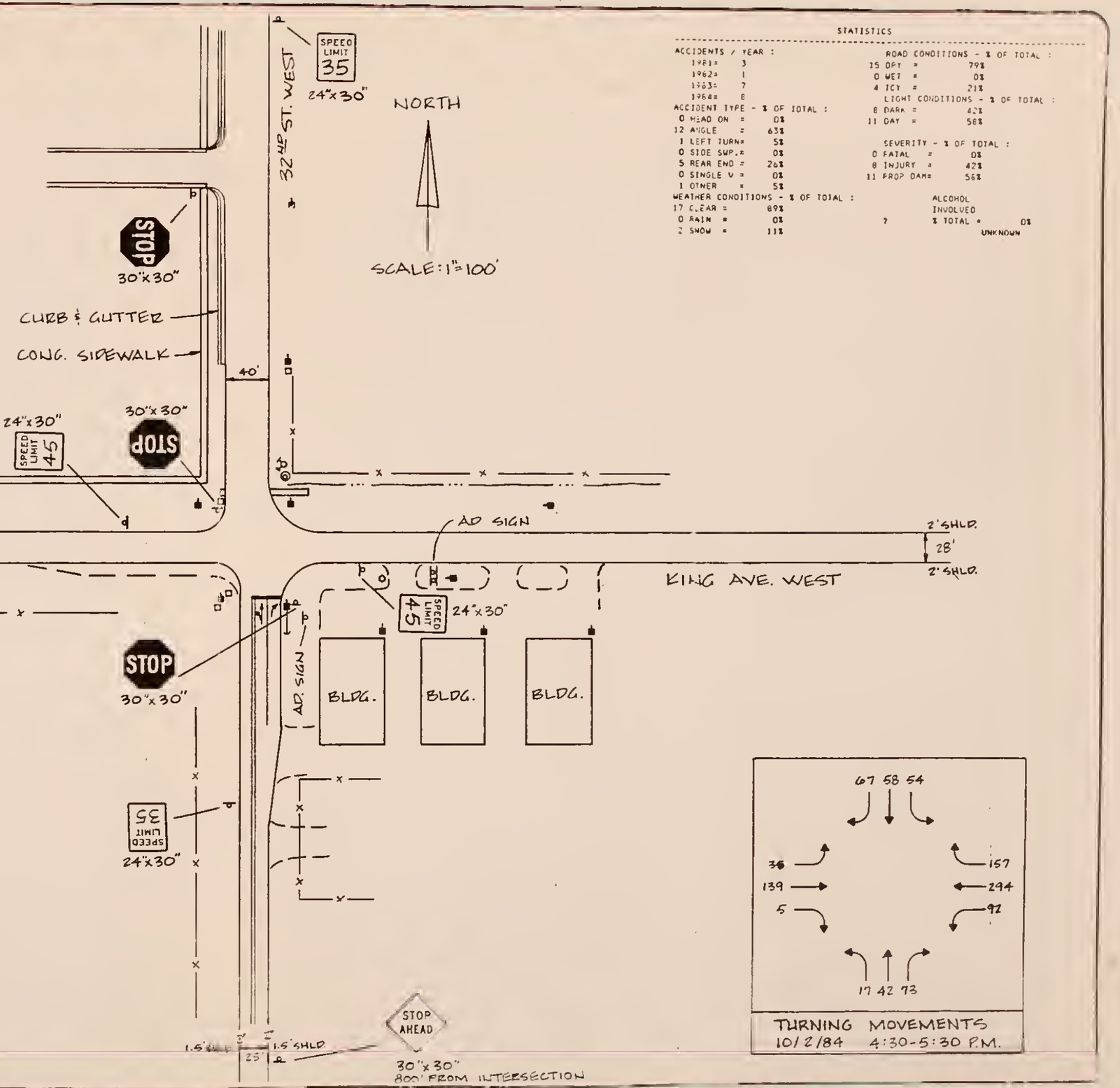
WEATHER CONDITIONS - % OF TOTAL :
- 17 CLEAR = 89%
- 0 RAIN = 0%
- 2 SNOW = 11%

ROAD CONDITIONS - % OF TOTAL :
- 15 DRY = 79%
- 0 WET = 0%
- 4 ICY = 21%

LIGHT CONDITIONS - % OF TOTAL :
- 8 DARK = 42%
- 11 DAY = 58%

SEVERITY - % OF TOTAL :
- 0 FATAL = 0%
- 8 INJURY = 42%
- 11 PROP DAM= 56%

ALCOHOL INVOLVED
- ? % TOTAL = 0%
- UNKNOWN



TURNING MOVEMENTS
10/2/84 4:30-5:30 P.M.

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers
SUITE 304 TRANSWESTERN
404 N. 31st
BILLINGS MT. 59101
PH. (406) 248-6086

Project: TRAFFIC SAFETY STUDY- YELLOWSTONE COUNTY ROADS

Sheet Title: KING AVE. W. & 32ND ST. W. EXISTING CONDITIONS

Surveyed By:
Designed By:
Drawn By:
Checked By:
Date:

Revisions
No. Date
No. Date
No. Date
No. Date

Project #
Sheet No.
of
Check No.

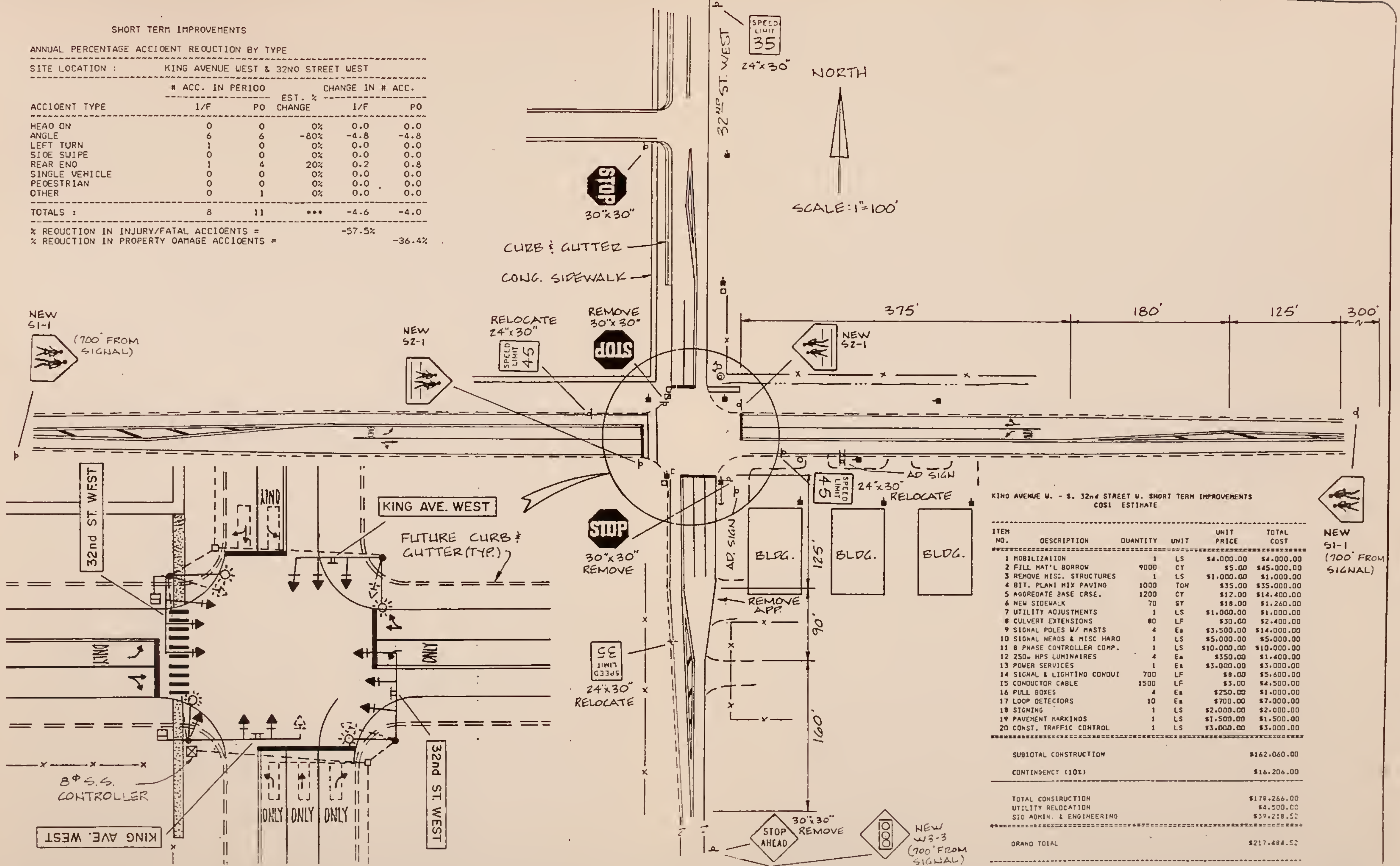
SHORT TERM IMPROVEMENTS

ANNUAL PERCENTAGE ACCIOENT REOUCTION BY TYPE

SITE LOCATION : KING AVENUE UEST & 32NO STREET UEST

ACCIOENT TYPE	# ACC. IN PERIOO I/F	# ACC. IN PERIOO PO	EST. % CHANGE	CHANGE IN # ACC. I/F	CHANGE IN # ACC. PO
HEAO ON	0	0	0%	0.0	0.0
ANGLE	6	6	-80%	-4.8	-4.8
LEFT TURN	1	0	0%	0.0	0.0
SIOE SUIPE	0	0	0%	0.0	0.0
REAR ENO	1	4	20%	0.2	0.8
SINGLE VEHICLE	0	0	0%	0.0	0.0
PEOESTRIAN	0	0	0%	0.0	0.0
OTHER	0	1	0%	0.0	0.0
TOTALS :	8	11	***	-4.6	-4.0

% REOUCTION IN INJURY/FATAL ACCIOENTS = -57.5%
% REOUCTION IN PROPERTY OAMAGE ACCIOENTS = -36.4%



KINO AVENUE U. - S. 32nd STREET U. SHORT TERM IMPROVEMENTS
COS1 ESTIMATE

ITEM NO.	OESCRIPTION	OUANTITY	UNIT	UNIT PRICE	TOTAL COST
1	MOBILIZA1ION	1	LS	$4.000.00	$4.000.00
2	FILL MAT'L BORROU	9000	CY	$5.00	$45.000.00
3	REMOVE MISC. STRUCTURES	1	LS	$1.000.00	$1.000.00
4	BIT. PLAN1 MIX PAVING	1000	TON	$35.00	$35.000.00
5	AOOREOATE BASE CRSE.	1200	CY	$12.00	$14.400.00
6	NEU SIOEUALK	70	SY	$18.00	$1.260.00
7	UTILITY AOJUSTMENTS	1	LS	$1.000.00	$1.000.00
8	CULVERT EXTENSIONS	80	LF	$30.00	$2.400.00
9	SIGNAL POLES U/ MASTS	4	Ea	$3.500.00	$14.000.00
10	SIGNAL NEAOS & MISC HARO	1	LS	$5.000.00	$5.000.00
11	8 PHASE CONTROLLER COMP.	1	LS	$10.000.00	$10.000.00
12	250w HPS LUMINAIRES	4	Ea	$350.00	$1.400.00
13	POUER SERVICES	1	Ea	$3.000.00	$3.000.00
14	SIGNAL & LIGHTINO CONOUI	700	LF	$8.00	$5.600.00
15	CONOUCTOR CABLE	1500	LF	$3.00	$4.500.00
16	PULL BOXES	4	Ea	$250.00	$1.000.00
17	LOOP OETECTORS	10	Ea	$700.00	$7.000.00
18	SIGNINO	1	LS	$2.000.00	$2.000.00
19	PAVEMENT MARKINOS	1	LS	$1.500.00	$1.500.00
20	CONST. TRAFFIC CONTROL	1	LS	$3.000.00	$3.000.00
	SUB1OTAL CONSTRUCTION				$162.060.00
	CONTINOENCY (10%)				$16.206.00
	TOTAL CONS1RUCTION				$178.266.00
	UTILITY RELOCATION				$4.500.00
	SIO ADMIN. & ENGINEERINO				$39.2:8.52
	ORANO TO1AL				$217.484.52

MARVIN & ASSOCIATES
Traffic Transportation & Civil Engineers

Project: TRAFFIC SAFETY STUDY - YELLOWSTONE COUNTY ROADS

Sheet Title: KING AVE W & 32ND ST WEST SHORT TERM IMPROVEMENTS

54TH STREET W.

NORTHEAST CORNER EAST ↖

GRAND AVE. EAST ↑

GRAND AVE. WEST ↑

SHEPHERD ROAD NORTH ↑

SHEPHERD ROAD SOUTH ↑

CHICAGO ROAD WEST ↑

CHICAGO ROAD EAST ↑

GOLF COURSE ROAD SOUTH ↑

GOLF COURSE ROAD SOUTH ↑

U.S. 10 E. EAST ↑

U.S. 10 E. WEST ↑

OLD HARDIN ROAD WEST ↑

OLD HARDIN ROAD EAST ↑

BECRAFT LANE NORTH ↗

STORE APP FROM JOHNSON LN EAST ↑

12 MILE ROAD NORTH ↑

12 MILE ROAD SOUTH ↑

HOMER DAVIS ROAD EAST ↑

HOMER DAVIS ROAD WEST ↑

OLD HARDIN ROAD EAST ↑

PICCOLO LANE NORTH ↑

OLD HARDIN ROAD WEST ↑

PICCOLO & PARKING LOT NORTH ↑

VERMILLION ROAD NORTH ↑

SHEPHERD ROAD SOUTH ↑

HIGHWAY 312 EAST ↑

HIGHWAY 312 WEST ↑

SHEPHERD ROAD NORTH ↑

SHEPHERD ROAD SOUTH ↑

SHEPHERD-ACTON RD. EAST ↑

SHEPHERD ROAD E. WEST ↑

OLD HARDIN ROAD EAST ↗

DICKIE ROAD SOUTH ↑

NEIBAUR ROAD EAST ↑

NEIBAUR ROAD WEST →

NEIBAUR ROAD EAST ↑

NEIBAUR ROAD WEST →

JELLISON ROAD EAST ↑

JELLISON ROAD WEST ↖

JELLISON ROAD MID INSIDE CURVE

DOVER ROAD EAST ↑

PIONEER ROAD SOUTH ↑

DOVER ROAD WEST ↑

DOVER ROAD WEST ↗

DOVER ROAD WEST ↖

INDEPENDENT ROAD EAST ↖

HIGHWAY 312 EAST ↗

HIGHWAY 312 WEST ↗

HIGHWAY 312 WEST ↗

LARIMER ROAD SOUTH ↑

McGIRL ROAD NORTH ↗

CLINE ROAD SOUTH ↗

56TH ST. W. SOUTH ↑

56TH ST. W. NORTH ↑

DANFORD RD. EAST ↑

DANFORD ROAD WEST ↑

HIGHWAY 312 EAST ↗

HIGHWAY 312 WEST ↗

HIGHWAY 312 EAST ↗

BARRY ROAD SOUTH ↑

OLD HARDIN ROAD
EAST ↑

ROSEBUD LANE WEST ↑

COBURN
ROAD
↑
NORTH

ROSEBUD LANE WEST ↑

DRURY LANE NORTH ↗

HIGHWAY 312 WEST ↗

PIONEER ROAD NORTH ↑

HIGHWAY 312 EAST ↗

HIGHWAY 312 EAST ↑

HUNTLEY APP RD NORTH ↑

HIGHWAY 312 WEST ↑

HUNTLEY APP RD NORTH ↗

S. 32ND ST. W NORTH ↑

S 32ND ST W SOUTH ↑

KING AVENUE W. EAST ↑

KING AVENUE W WEST ↑